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CHEMISTRY today

Volume 27 No. 12 December 2018

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CONTENTS

Printed and Published by Mahabir Singh on behalf of MTG Learning Media Pvt. Ltd. Printed at HT Media Ltd., B-2, Sector-63, Noida, UP-201307 and published at 406, Taj Apartment, Ring Road, Near Safdarjung Hospital, New Delhi - 110029.
Editor : Anil Ahlawat

FOCUS NEET/JEE 2019

Class XI

Focus more to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

UNIT - 6 : The *p*-Block Elements (Group 13 & 14)

- The elements in which the last electron enters into any of the outermost *p*-orbitals are called *p*-block elements.
- The general outer electronic configuration of the *p*-block elements is ns^2np^{1-6}.
- The elements belonging to the group 13 to 18 of the long form of periodic table are *p*-block elements. The *p*-block elements include metals, non-metals and metalloids.

Group 13 elements (Boron Family)

- Group 13 of the periodic table contains six elements boron (B), aluminium (Al), gallium (Ga), indium (In), thallium (Tl) and Nihonium (Nh). Aluminium is the most abundant of these elements. Boron occurs rather sparsely and gallium, indium, thallium are not found in concentrated deposits.

Electronic Configuration

Element	Symbol	Electronic configuration [noble gas] ns^2np^1
Boron	$_5B$	$[He]2s^22p^1$
Aluminium	$_{13}Al$	$[Ne]3s^23p^1$
Gallium	$_{31}Ga$	$[Ar]3d^{10}4s^24p^1$
Indium	$_{49}In$	$[Kr]4d^{10}5s^25p^1$
Thallium	$_{81}Tl$	$[Xe]4f^{14}5d^{10}6s^26p^1$
Nihonium	$_{113}Nh$	$[Rn]5f^{14}6d^{10}7s^27p^1$

Atomic and Physical Properties

Increasing trends	Decreasing trends
Atomic radii	Ionisation energies
Ionic radii	M.P./B.P.
Stability of + 1 oxidation state (Inert pair effect)	Stability of + 3 oxidation state
Ionic character	Covalent character
Electropositive character	Electronegativity
Density	

Chemical Properties

- All the elements of group 13 form trioxides (E_2O_3) when heated in dioxygen (Tl also forms some Tl_2O).
  $4E_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2E_2O_{3(s)}$ (E = element)
  The nature of oxides varies down the group.
  $\underset{\text{Acidic}}{B_2O_3}$ $\underset{\text{Amphoteric}}{Al_2O_3, Ga_2O_3}$ $\underset{\text{Basic}}{In_2O_3, Tl_2O_3, Tl_2O}$
- Boron and aluminium form nitrides when heated with nitrogen at high temperature.
  $2E_{(s)} + N_{2(g)} \xrightarrow{\Delta} 2EN_{(s)}$ (E = element)
- Boron does not react with acids and alkalies even at moderate temperature, but aluminium dissolves in mineral acids and aqueous alkalies and thus, shows amphoteric character. However, concentrated nitric acid renders aluminium passive by forming a protective oxide layer on the surface.

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- Group 13 elements react with halogens to form trihalides except TlI_3.
  $2E_{(s)} + 3X_{2(g)} \longrightarrow 2EX_{3(s)}$ (X = F, Cl, Br, I)
- The covalent trihalides *e.g.*, BF_3 being electron deficient are strong Lewis acids and the tendency to behave as Lewis acids decreases with increase in size down the group.

Preparation, Properties and Uses of Boron

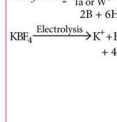
Preparation	Physical properties	Chemical properties	Uses
$B_2O_3 + 3Mg \xrightarrow{\text{Heat}} 3MgO + 2B_{(s)}$	• It is extremely hard solid.	$2B + 3X_2 \longrightarrow 2BX_3$	• In making filaments which are used in making light composite materials for aircraft.
$2BX_3 + 3H_2 \xrightarrow[\text{Ta or W}]{1270\ K} 2B + 6HX$	• It is non-metallic.	$B + 3HNO_3 \underset{\text{(conc.)}}{\longrightarrow} H_3BO_3 + 3NO_2\uparrow$	• As semiconductor in making electronic devices.
$KBF_4 \xrightarrow{\text{Electrolysis}} K^+ + B^{3+} + 4F^-$	• It has two allotropes : – **Crystalline boron :** Black and chemically inert. It is very hard in nature. – **Amorphous boron:** Brown and chemically active.	$2B + 3H_2SO_4 \underset{\text{(conc.)}}{\longrightarrow} 2H_3BO_3 + 3SO_2\uparrow$ $4B + 3O_2 \longrightarrow 2B_2O_3$ $2B + N_{2(g)} \longrightarrow 2BN_{(s)}$	• In preparation of metal borides which are used as protective shields and control rods in nuclear reactors.
$B_2H_6 \xrightarrow[1773\ K]{\text{Heat}} 2B + 3H_2$	• It is poor conductor of heat and electricity. • It has two isotopes : $^{10}_{5}B(20\%)$ and $^{11}_{5}B(80\%)$.	$2B + 6NaOH \xrightarrow{>773\ K} 2Na_3BO_3 + 3H_2$ $2B + 3H_2O \underset{\text{(Steam)}}{\longrightarrow} B_2O_3 + 3H_2$ (Red hot)	• In steel industry for increasing the hardness of steel.

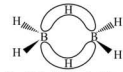
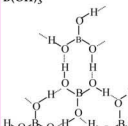
Anomalous Properties of Boron

- Due to the smallest size, high ionisation energy, absence of vacant *d*-orbitals and high electronegativity boron shows anomalous behaviour as compared to other members of the group.

Property	Boron	Other elements of group 13
Metallic behaviour	Non-metal	Metals
Covalency	Maximum-4	Maximum-6
Allotropy	Exhibits	Do not exhibit
Oxidation states	Only +3	+1, +3
Compounds	Only covalent	Both ionic and covalent
Halides	Monomeric	Polymeric
Oxides and hydroxides	Acidic	Mainly basic
Combination with metals	Forms boride	Do not combine (form alloy)

Some Important Compounds of Boron

Compound	Preparation	Properties	Uses
Borax ($Na_2B_4O_7 \cdot 10H_2O$)  $[B_4O_5(OH)_4]^{2-}$	• $Ca_2B_6O_{11} + 2Na_2CO_3 \longrightarrow$ Colemanite $2CaCO_3\downarrow + Na_2B_4O_7$ Cal. carbonate Borax $+ 2NaBO_2$ Metaborate $4NaBO_2 + CO_2 \longrightarrow Na_2B_4O_7 + Na_2CO_3$ • $4H_3BO_3 + Na_2CO_3 \longrightarrow Na_2B_4O_7 + CO_2\uparrow + 6H_2O$	• $Na_2B_4O_7 + 7H_2O \rightleftharpoons 2NaOH + 4H_3BO_3$ Strong alkali Weak acid • $Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 + 10H_2O$ $Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$ (Glassy mass) $CuSO_4 \longrightarrow CuO + SO_3\uparrow$ $CuO + B_2O_3 \longrightarrow Cu(BO_2)_2$ (Bluish green bead)	• in borax bead test • as a flux for soldering and welding • in making glazes and enamels • in making boro-silicate glass • used as a water softener and cleaning agent.

Diborane (B_2H_6)  Four 2c-2e B–H terminal bonds Two 3c-2e B–H bridging bonds	• $4BF_3 + 3LiAlH_4 \xrightarrow{\text{Diethyl ether}} 2B_2H_6 + 3LiF + 3AlF_3$ • **Laboratory Method** $2NaBH_4 + I_2 \longrightarrow B_2H_6 + 2NaI + H_2$ • **Industrial Method** $2BF_3 + 6NaH \xrightarrow{450\ K} B_2H_6 + 6NaF$	• $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$ • $B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$ • $B_2H_6 + 6CH_3OH \longrightarrow 2B(OCH_3)_3 + 6H_2$ • $B_2H_6 + 2NMe_3 \longrightarrow 2BH_3{\cdot}NMe_3$ $B_2H_6 + 2CO \longrightarrow 2BH_3{\cdot}CO$	• for preparing a number of borohydrides such as $LiBH_4$, $NaBH_4$, etc. • as a reducing agent in organic reactions.
Orthoboric acid (H_3BO_3) or $B(OH)_3$ 	• **From borax :** $Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 4H_3BO_3 + 2NaCl$ $Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow 4H_3BO_3 + Na_2SO_4$ • **By hydrolysis of boron compounds :** $BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$ $B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$ $BN + 3H_2O \longrightarrow H_3BO_3 + NH_3$	• It is a weak monobasic acid. It is not a protonic acid but acts as Lewis acid. $B(OH)_3 + 2HOH \longrightarrow [B(OH)_4]^- + H_3O^+$ • **Action of heat :** $H_3BO_3 \xrightarrow{370\ K}$ (Boric acid) HBO_2 (Metaboric acid) $+ H_2O$ $4HBO_2 \xrightarrow[-H_2O]{410\ K}$ (Metaboric acid) $H_2B_4O_7$ (Tetraboric acid) $\xrightarrow[\text{heat}]{\text{Red}} 2B_2O_3 + H_2O$ (Boron trioxide)	• It is used in the manufacture of heat resistant borosilicate glass. • The aqueous solution of boric acid is used as a mild antiseptic especially as eye wash under the name *boric lotion*.

Group 14 Elements (Carbon Family)

- Group 14 of the periodic table contains six elements which are carbon, silicon, germanium, tin, lead and Flerovium. Carbon is an essential constituent of all organic matter while silicon is the main constituent of inorganic matter.

Element	Symbol	Electronic configuration
Carbon	$_6C$	$[He]2s^2 2p^2$
Silicon	$_{14}Si$	$[Ne]3s^2 3p^2$
Germanium	$_{32}Ge$	$[Ar]3d^{10} 4s^2 4p^2$
Tin	$_{50}Sn$	$[Kr]4d^{10} 5s^2 5p^2$
Lead	$_{82}Pb$	$[Xe]4f^{14} 5d^{10} 6s^2 6p^2$
Flerovium	$_{114}Fl$	$[Rn]5f^{14} 6d^{10} 7s^2 7p^2$

Physical Properties

Atomic or covalent radii	C < Si < Ge < Sn < Pb
Ionisation energy	C > Si > Ge > Sn > Pb
Electronegativity	C > Si = Ge = Sn < Pb
Oxidation state	Stability of +4 oxidation state decreases down the group while that of +2 increases.
Melting and boiling points	Decrease from carbon to lead.
Density	Increases from C to Pb
Allotropy	All elements show allotropy

Reactivity of the Elements of Group 14

- Elements in this group are relatively unreactive but reactivity increases down the group. Pb often appears more noble than expected due to a surface coating of oxide and partly due to high over potential for the reduction of H^+ to H_2 at a lead surface.

Reagent	Reactivity
H_2O	C, Si, Ge, Pb are unaffected by H_2O.
	$Sn + 2H_2O \longrightarrow SnO_2 + 2H_2$ (steam)

Dilute acids	C, Si, Ge are unaffected by dilute acids.
	Pb does not dissolve in dilute H_2SO_4 due to formation of $PbSO_4$ coating.
Concentrated acids	Diamond is unaffected by concentrated acids, but graphite is oxidised by concentrated HNO_3 to give graphitic acid ($C_{11}H_4O_5$) which is an insoluble yellowish green substance and to graphite oxide with hot concentrated HF/HNO_3.
	Si is oxidised and changes to SiF_4 by hot concentrated HNO_3/HF.
	Pb does not dissolve in concentrated HCl due to formation of $PbCl_2$ coating.
Alkalies	Carbon is unaffected by alkalies.
	Sn and Pb are slowly attacked by cold alkali, and rapidly by hot alkali, giving stannates $Na_2[Sn(OH)_6]$ and plumbates $Na_2[Pb(OH)_6]$.
Complex formation	Si, Ge, Sn and Pb can show coordination number more than 4. *e.g.*, Si, Ge (6), Sn, Pb (8)
Halogens	Diamond is unreactive, but graphite reacts forming $(CF)_n$.
	Si and Ge form volatile SiX_4 and GeX_4 respectively.
	Sn and Pb are less reactive. Sn reacts with Cl_2 and Br_2 in cold, and with F_2 and I_2 on warming. Lead reacts with F_2 in cold and with Cl_2 on heating forming PbX_2.

Crystalline Allotropes of Carbon

- **Diamond :** A rigid three-dimensional network of sp^3 hybridised carbon atoms, hardest substance known and used as an abrasive.
- **Graphite :** Most stable allotrope, having layered structure in which each layer has sp^2 hybridised carbon atoms in hexagonal rings and adjacent layers are held together by van der Waals' forces, soft, slippery, conductor of electricity and used as lubricant in machines.
- **Fullerenes :** Pure form of carbon, consists mainly of C_{60}, have shape like soccer ball (also called Buckminsterfullerene) which contains 20 six-membered rings and 12 five-membered rings and all carbon atoms are sp^2 hybridised.

Amorphous Allotropes of Carbon

- Carbon black, coke and charcoal are all impure forms of graphite or fullerenes.

Important Compounds of Carbon and Silicon

Compound	Preparation	Properties	Structure
Carbon monoxide (CO)	$2C_{(s)} + O_{2(g)} \xrightarrow{\Delta} 2CO_{(g)}$ $HCOOH \xrightarrow[\text{Conc. } H_2SO_4]{373\ K} H_2O + CO$ **Commercial Preparation :** $C_{(s)} + H_2O_{(g)} \xrightarrow{473-1273\ K} \underbrace{CO + H_2}_{\text{Water gas}}$ $2C + O_2 + 4N_2 \xrightarrow{473-1273\ K} \underbrace{2CO + 4N_2}_{\text{Producer gas}}$	$2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}; \Delta H = -12.68$ kcal $3CO_{(g)} + Fe_2O_{3(s)} \xrightarrow{\Delta} 2Fe_{(s)} + 3CO_{2(g)}$ $CO_{(g)} + ZnO_{(s)} \xrightarrow{\Delta} Zn_{(s)} + CO_{2(g)}$ $4CO + Ni \xrightarrow{80°C} [Ni(CO)_4]$ $5CO + Fe \xrightarrow{180°C} [Fe(CO)_5]$ Highly poisonous due to the fomation of a complex with haemoglobin (Hb) which is 300 times more stable than O_2–Hb complex thus, prevents Hb in the RBCs from carrying O_2 around the body.	:C≡Ö: ↔ :C≡Ö: or :Ċ=O:
Carbon dioxide (CO_2)	$C_{(s)} + O_{2(g)} \xrightarrow{\Delta} CO_{2(g)}$ $CH_{4(g)} + 2O_{2(g)} \xrightarrow{\Delta} CO_{2(g)} + 2H_2O_{(g)}$ **Laboratory Method :** $CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$	$2Mg + CO_2 \longrightarrow 2MgO + C$ $CO_2 + H_2O \rightleftharpoons H_2CO_3$ $CO_2 + Ca(OH)_2 \longrightarrow \underset{\text{(Insoluble)}}{CaCO_3} + H_2O$ $CO_2 + CaCO_3 + H_2O \longrightarrow \underset{\text{Soluble}}{Ca(HCO_3)_2}$ $CO_2 + C \longrightarrow 2CO$ $6CO_2 + 6H_2O \xrightarrow{h\nu} C_6H_{12}O_6 + 6O_2$	:Ö::C≡Ö: ↔ :Ö=C=Ö: :Ö≡C–Ö:⁻

Uses : It is used

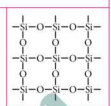
- In the manufacture of soda.
- As carbogen [mixture of O_2 + CO_2 (5-10%)] in artificial respiration especially for pneumonia patients and victims of CO poisoning.
- As a fire extinguisher.

Silicon dioxide (SiO_2)

Covalent, three dimensional network solid.
Almost non-reactive due to high Si—O bond enthalpy.
However, it is attacked by HF and NaOH.

$SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$

$SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$



Uses :

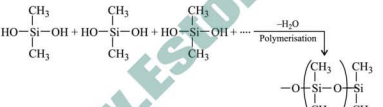
- Quartz is extensively used as a piezoelectric material.
- It has made possible to develop extremely accurate clocks, modern radio and television broadcasting and mobile radio communications.
- Silica gel is used as a drying agent and as a support for chromatographic materials and catalysts.
- Kieselguhr, an amorphous form of silica is used in filtration plants.

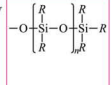
Silicones

where *R* = alkyl or phenyl group

- Synthetic organosilicon polymers containing repeated R_2SiO units held by Si—O—Si linkage.
- They are water repelling due to non-polar alkyl groups.

$$2CH_3Cl + Si \xrightarrow[570\ K]{Cu\ power} (CH_3)_2SiCl_2 \xrightarrow[-2HCl]{+2H_2O} [(CH_3)_2Si(OH)_2$$





Uses : They are used as sealant, greases, electrical insulators and for water proofing of fabrics. Being biocompatible they are also used in surgical and cosmetic plants.

Different Types of Silicates

1. **Orthosilicates :** Basic unit : SiO_4^{4-}, *e.g.*, Zircon–$ZrSiO_4$, Forsterite–Mg_2SiO_4
2. **Pyrosilicates or islands :** Basic unit : $Si_2O_5^{6-}$, *e.g.*, Thortveitite–$Sc_2Si_2O_7$, Hemimorphite- $Zn_3(Si_2O_7)\cdot Zn(OH)_2\cdot H_2O$
3. **Cyclic or ring silicates :** Basic unit : $(SiO_3^{2-})_n$ or $(SiO_3)_n^{2n-}$, *e.g.*, Wollastonite–$Ca_3Si_3O_9$, Beryl–$Be_3Al_2Si_6O_{18}$
4. **Chain silicates :** Basic unit : $(SiO_3)_n^{2n-}$ or $(Si_4O_{11})_n^{6n-}$, *e.g.*, Spodumene–$LiAl(SiO_3)_2$, Diopside–$CaMg(SiO_3)_2$
5. **Sheet silicates (two-dimensional) :** Basic unit : $(Si_2O_5)_n^{2n-}$ or $(Si_2O_5^{2-})_n$, *e.g.*, Kaolin–$Al_2(OH)_4(Si_2O_5)$, Talc–$Mg(Si_2O_5)_2Mg(OH)_2$
6. **Three-dimensional silicates :** These silicates involve all four oxygen atoms in sharing with adjacent SiO_4^{4-} tetrahedra, *e.g.*, Zeolites, Quartz, Feldspar, Ultramarines, etc.

SPEED PRACTICE

1. The gas produced by the reaction of formic acid with conc. H_2SO_4 is reacted with conc.NaOH at 200 °C and 5-10 atm. The product obtained is
(a) CO (b) CO_2
(c) HCOONa (d) CH_3COONa

2. The straight chain polymer is formed by
(a) hydrolysis of CH_3SiCl_3 followed by condensation polymerisation
(b) hydrolysis of $(CH_3)_4Si$ by addition polymerisation
(c) hydrolysis of $(CH_3)_2SiCl_2$ followed by condensation polymerisation
(d) hydrolysis of $(CH_3)_3SiCl$ followed by condensation polymerisation.

3. The increasing order of atomic radii of the following group 13 elements is
(a) Al < Ga < In < Tl (b) Ga < Al < In < Tl
(c) Al < In < Ga < Tl (d) Al < Ga < Tl < In
(JEE Advanced 2016)

4. $SiCl_4 \xrightarrow{H_2O} (A) \xrightarrow{\Delta} (B) \xrightarrow[\text{Heat}]{Na_2CO_3} (C)$
The compound (*C*) is
(a) SiO_2 (b) Si (c) SiC (d) Na_2SiO_3

5. With respect to graphite and diamond which of the statements given below is correct?
(a) Graphite is harder than diamond.
(b) Graphite has higher electrical conductivity than diamond.
(c) Graphite has higher refractive index than diamond.
(d) Graphite has lower thermodynamic stability.

6. Which one of the following elements is unable to form MF_6^{3-} ion?
(a) Ga (b) Al (c) B (d) In
(NEET 2018)

7. A metal *M* forms chlorides in its +2 and +4 oxidation states. Which of the following statements about these chlorides is correct?
(a) MCl_2 is more ionic than MCl_4.
(b) MCl_2 is more easily hydrolysed than MCl_4.
(c) MCl_2 is more volatile than MCl_4.
(d) MCl_2 has lower melting point than that of MCl_4.

8. The bond dissociation energy of B—F in BF_3 is 646 kJ mol^{-1} whereas that of C—F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B—F bond dissociation energy as compared to that of C—F bond is
(a) stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4
(b) significant $p\pi$-$p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4
(c) lower degree of $p\pi$-$p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4
(d) smaller size of B-atom as compared to that of C-atom.

9. The correct acidic character shown by boron halides is
(a) $BF_3 > BCl_3 > BBr_3$ (b) $BF_3 < BCl_3 < BBr_3$
(c) $BBr_3 < BCl_3 < BF_3$ (d) $BCl_3 < BF_3 < BBr_3$

10. $B(OH)_3 + NaOH \rightleftharpoons NaBO_2 + Na[B(OH)_4] + H_2O$
How can this reaction is made to proceed in forward direction?
(a) Addition of *cis*-1,2-diol
(b) Addition of borax
(c) Addition of *trans*-1,2-diol
(d) Addition of Na_2HPO_4

11. Ge(II) compounds are powerful reducing agents, whereas Pb(IV) compounds are strong oxidants. It is due to the fact that
(a) lead is more electropositive than germanium
(b) the ionisation potential of lead is less than that of germanium
(c) the ionic radii of Pb^{2+} are larger than those of Ge^{2+} and Ge^{4+}
(d) more pronounced inert pair effect in lead than in germanium.

12. $B_2O_3 + X \longrightarrow B$. Which of the following is not *X*?
(a) Na (b) K (c) H_2 (d) Mg

13. Select the incorrect statement.
(a) In $Si_2O_7^{6-}$, there is one shared oxygen.
(b) $Si_6O_{18}^{12-}$ represents a cyclic silicate with two shared oxygens per silicon atom.
(c) Pyroxene is a linear chain silicate with two shared oxygens per silicon atom.

(d) In three dimensional network silicate, there are three shared oxygens per silicon atom.

14. Consider the following standard electrode potentials (E^o in volts) in aqueous solution,

Element	M^{3+}/M	M^{+}/M
Al	−1.66	+ 0.55
Tl	+1.26	−0.34

Based on these data, which of the following statements is correct?
(a) Tl^+ is more stable than Al^+.
(b) Tl^{3+} is more stable than Al^{3+}.
(c) Al^+ is more stable than Al^{3+}.
(d) Tl^+ is more stable than Al^{3+}.

(JEE Main Online 2017)

15. The reducing power of divalent species in group 14th increases as
(a) Pb < Sn < Ge (b) Pb < Ge < Sn
(c) Ge < Sn < Pb (d) Ge < Pb < Sn

16. Antidote for CO poisoning is
(a) carborundum (b) pure CO_2
(c) carbogen (d) carbonyl chloride.

17. $B_{(s)} \xrightarrow{Z} X \xrightarrow{LiH} Y + LiBF_4$

Which of the given statements is true for the above sequence of reactions?
(a) Z is hydrogen. (b) Y is $LiBH_4$.
(c) Z and Y are F_2 and B_2H_6 respectively.
(d) Z is potassium hydroxide.

18. Aluminium chloride exists as dimer, Al_2Cl_6 in solid state as well as in solution in non-polar solvents like benzene. When dissolved in water, it gives
(a) $Al^{3+} + 3Cl^-$ (b) $Al_2O_3 + 6HCl$
(c) $[Al(OH)_6]^{3-} + 3HCl$ (d) $[Al(H_2O)_6]^{3+} + 3Cl^-$

19. Choose the incorrect option.
(a) Tendency to form ionic compound increases from B to Tl.
(b) Boron forms only covalent compounds.
(c) Thallium forms only ionic compounds.
(d) Group 13 elements have less tendency to form complexes than the *s*-block elements.

20. When metal '*M*' is treated with NaOH, a white gelatinous precipitate '*X*' is obtained, which is soluble in excess of NaOH. Compound '*X*' when heated strongly gives an oxide which is used in chromatography as an adsorbent. Then metal '*M*' is
(a) Zn (b) Ca (c) Al (d) Fe

(JEE Main 2018)

21. Which of the following is not hydrolysed easily?
(a) CCl_4 (b) $SiCl_4$ (c) $SnCl_4$ (d) $PbCl_4$

22. Compound '*X*' on reduction with $LiAlH_4$ gives a hydride '*Y*' containing 21.72% hydrogen along with other products. The compound '*Y*' reacts with air explosively to give B_2O_3. '*X*' and '*Y*' are respectively
(a) B_2H_6 and BCl_3 (b) BCl_3 and B_2H_6
(c) $AlCl_3$ and AlH_4 (d) BCl_3 and B_4H_8

23. Unlike $PbCl_4$, PbI_4 and $PbBr_4$ are not found because
(a) bromine and iodine are more electronegative than chlorine
(b) iodine and bromine are smaller in size
(c) larger iodine and bromine are able to reduce Pb^{4+} to Pb^{2+} or Pb
(d) Cl^- is a better reducing agent than Br^- and I^-.

24. AlF_3 is soluble in HF only in presence of KF. It is due to the formation of
(a) $K_3[AlF_3H_3]$ (b) $K_3[AlF_6]$
(c) AlH_3 (d) $K[AlF_3H]$

(NEET Phase-II 2016)

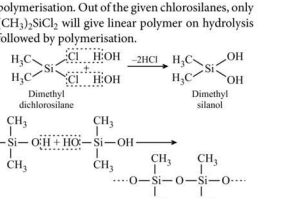
25. The catenation tendency of C, Si and Ge is in the order Ge < Si < C. The bond energies (in kJ mol^{-1}) of C–C, Si–Si and Ge–Ge bond respectively are
(a) 260, 297 and 348 (b) 270, 160 and 348
(c) 348, 260 and 297 (d) 348, 297 and 260

SOLUTIONS

1. (c) : $HCOOH \xrightarrow{H_2SO_4(Conc.)} CO + H_2O$

$CO + NaOH_{(conc.)} \xrightarrow[200°C/5–10 atm]{\Delta} HCOONa$

2. (c) : Hydrolysis of substituted chlorosilanes yields corresponding silanols which undergo polymerisation. Out of the given chlorosilanes, only $(CH_3)_2SiCl_2$ will give linear polymer on hydrolysis followed by polymerisation.



3. (b) : The increasing order of atomic radii of group-13 elements is Ga < Al < In < Tl.

Atomic radius of Ga is slightly lower than that of Al due to the presence of *d*-electrons in Ga which do not shield the nucleus effectively.

4. **(d):** $SiCl_4 + 4H_2O \longrightarrow \underset{(A)}{Si(OH)_4}$

$$CO_2 + Na_2SiO_3 \xleftarrow{Na_2CO_3} \underset{(C)}{SiO_2} + 2H_2O \quad (B)$$

5. **(b):** Graphite has higher electrical conductivity than diamond because after sp^2 hybridization, the fourth valence electron of each carbon is free to move.

6. **(c):** Boron does not have vacant *d*-orbitals in its valence shell, so it cannot extend its covalency beyond 4 *i.e.*, 'B' cannot form the ions like MF_6^{3-}.

7. **(a):** *M* is from group 14. Therefore, MCl_2 is more ionic than MCl_4.

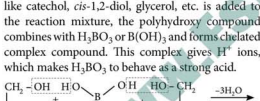
8. **(b):** In BF_3, $p\pi$-$p\pi$ back bonding in 2*p*-2*p* orbitals makes the bond strong and smaller.

9. **(b):** Back bonding in BF_3 is maximum and minimum in BBr_3.

10. **(a):** Given reaction is not possible, because sodium metaborate, $Na^+[B(OH)_4]^-$ formed by the reaction between $B(OH)_3$ and NaOH gets hydrolysed to regenerate $B(OH)_3$ and NaOH.

$Na^+[B(OH)_4]^- \rightleftharpoons B(OH)_3 + NaOH$

However, if some quantity of polyhydroxy compound like catechol, *cis*-1,2-diol, glycerol, etc. is added to the reaction mixture, the polyhydroxy compound combines with H_3BO_3 or $B(OH)_3$ and forms chelated complex compound. This complex gives H^+ ions, which makes H_3BO_3 to behave as a strong acid.



chelated complex compound

Trans-1, 2-diol cannot be used in this reaction since it will not result in chelate formation.

11. **(d):** Ge^{2+} is less stable than Ge^{4+} but due to inert pair effect, Pb^{2+} is more stable than Pb^{4+}.

12. **(c):** H_2 cannot reduce B_2O_3.

13. **(d):** In three dimensional network silicates, there are four shared oxygens per silicon atom.

14. **(a):** Al^{3+} is more stable than Tl^{3+} because of negative $E^\circ_{Al^{3+}/Al}$ value.
Tl^+ is more stable than Al^+ because of negative $E^\circ_{Tl^+/Tl}$ value.

15. **(a):** Stability of +2 and +4 oxidation states is in the order $Pb^{2+} > Sn^{2+} > Ge^{2+}$ and $Pb^{4+} < Sn^{4+} < Ge^{4+}$. Clearly, Pb^{4+} will change to Pb^{2+} most easily. It is due to inert pair effect.
Ge^{2+} is best reducing and Pb^{4+} is best oxidizing agent.

16. **(c):** Antidote for CO poisoning is carbogen which is a mixture of 95% O_2 and 5% CO_2.

17. **(c):** $\underset{(s)}{B} \xrightarrow{F_2(Z)} \underset{(X)}{BF_3} \xrightarrow{LiH} \underset{(Y)}{B_2H_6} + LiBF_4$

18. **(d):** $\frac{1}{2}\underset{(X)}{Al_2Cl_6} + 6H_2O \longrightarrow \underset{(Y)}{[Al(H_2O)_6]^{3+}} + 3Cl^-$

19. **(d):** Group 13 elements have more tendency to form complexes than *s*-block elements due to their small size and more effective nuclear charge as well as vacant orbitals to accept electrons.

20. **(c):** Metal *M* could be Al as $Al(OH)_3$ is soluble in excess sodium hydroxide to form hydroxy aluminate ions. Al_2O_3 (oxide of metal *M*) is used as adsorbent in chromatography.

$$\underset{(M)}{Al} + 3NaOH \longrightarrow \underset{(X)}{Al(OH)_3}\downarrow + 3Na^+$$

White ppt.

$\downarrow$ NaOH (excess)

$Na[Al(OH)_4]$

Sodium tetrahydroxoaluminate(III)

(Soluble)

21. **(a)**

22. **(b):** $\underset{(X)}{4BCl_3} + 3LiAlH_4 \longrightarrow \underset{(Y)}{2B_2H_6} + 3AlCl_3 + 3LiCl$

$$\%\text{ of H in } B_2H_6 = \frac{6}{27.6} \times 100 = 21.72$$

$$\underset{(Y)}{B_2H_6} + 3O_2 \xrightarrow[(air)]{\text{Explosion}} B_2O_3 + 3H_2O$$

23. **(c):** Pb^{4+} has higher polarizing power and Br^- and I^- being larger in size can easily give the electrons to Pb^{4+} *i.e.*, as compared to Cl^-, Br^- and I^- are good reducing agents.

24. **(b):** AlF_3 is insoluble in anhydrous HF because the F^- ions are not available in hydrogen bonded HF but, it becomes soluble in presence of little amount of KF due to formation of complex, $K_3[AlF_6]$.

$AlF_3 + 3KF \longrightarrow K_3[AlF_6]$

25. **(d):** The higher the bond energies of element-element bond, more is the catenation tendency.

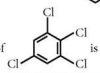
Class XI

Be NEET READY

with exclusive and brain storming MCQs

Practicing these MCQs helps to strengthen your concepts and give you extra edge in your NEET preparation

1. The dipole moment of chlorobenzene  is 1.5 D.

The dipole moment of  is

(a) 2.86 D (b) 2.25 D
(c) 1.5 D (d) 0 D

2. $B_2H_6 + NH_3 \xrightarrow[\text{heating}]{\text{Slow}} X \xrightarrow{\Delta} Y$

Which of the following statements is correct?
(a) *X* is ionic in nature, hybridisation of B atoms in both cationic and anionic part is different.
(b) *X* is ionic in nature, hybridisation of B atoms in both cationic and anionic part is same.
(c) *Y* is covalent nature and hybridisation of all B atoms is not same.
(d) *Y* is ionic in nature and hybridisation of all B atoms is same.

3. In which of the following reactions there is no change in oxidation number?
(a) $4KClO_3 \rightarrow 3KClO_4 + KCl$
(b) $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$
(c) $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$
(d) $2BaO + O_2 \rightarrow 2BaO_2$

4. A drop of 12.0 M HCl is spread over a sheet of thin aluminium foil. Assume that all the acid reacts and thus, dissolves through the foil. (Given that 20 drops make 1 mL, density of Al foil = 2.7 g/cm^3 and thickness = 0.10 mm.) The area of the cylindrical hole is
(a) 2.0 cm^2 (b) 0.1 cm^2
(c) 4.0 cm^2 (d) 0.2 cm^2

5. An organic compound has C and H percentage in the ratio 6 : 1 and C and O percentage in the ratio 3 : 4. The compound is
(a) HCHO (b) CH_3OH
(c) CH_3CH_2OH (d) $(COOH)_2$

6. A spherical balloon of 21 cm diameter is to be filled with H_2 at NTP from a cylinder containing the gas at 20 atm at 27 °C. The cylinder can hold 2.82 L of water at NTP. The number of balloons that can be filled up is
(a) 15 (b) 10 (c) 20 (d) 25

7. 100 mL of tap water containing $Ca(HCO_3)_2$ was titrated with N/50 HCl with methyl orange as indicator. If 30 mL of HCl was required, calculate the temporary hardness as parts of $CaCO_3$ per 10^6 parts of water.
(a) 150 ppm (b) 600 ppm
(c) 450 ppm (d) 300 ppm

8. Consider the following dissociation of O_2 (dissociation energy = 498 kJ mol^{-1})
$O_2 \xrightarrow{h\nu} O + O^*$

(O^*) is more energetic than normal oxygen atom (O) by 1.853 eV. Thus, maximum wavelength for photochemical dissociation is

(a) 174 nm (b) 172 nm
(c) 177 nm (d) 394 nm

9. Limestone $\xrightarrow{(p)}$ Quick lime $\xrightarrow[K_2O_2]{H_2O}$ (q) $\xrightarrow[\text{compressed}]{}$ (r) + KOH, $(q) \downarrow (s)$, $(q) + H_2O_2$

Which of the following options describes the correct reactants, products and reaction conditions?

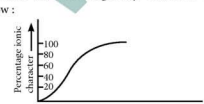
	(p)	(q)	(r)	(s)
(a)	Strong heating	Slaked lime	CaO	Cold water
(b)	Strong heating	Slaked lime	CaO_2	Cold water
(c)	Strong heating in presence of catalyst	Slaked lime	CaO	Cold water
(d)	Strong heating	Slaked lime (under high pressure)	CaO_2	Hot water

10. The major product of the following reaction,

$H_3C-C\equiv CH \xrightarrow[\text{ether}]{CH_3CH_2MgCl}$  $\xrightarrow{H_3O^+}$ is

(a) 
(b) 
(c) 
(d) 

11. Ionic character of a bond ($H-X$) varies with the difference in electronegativity values as shown below :



50% ionic character of HX is when EN difference is

(a) 1.4 (b) 1.5 (c) 1.6 (d) 1.7

12. What $[H_3O^+]$ must be maintained in a saturated H_2S solution to precipitate Pb^{2+}, but not Zn^{2+} from a solution in which each ion is present at a concentration of 0.01 M?
(K_{sp} of $H_2S = 1.1 \times 10^{-22}$; K_{sp} of $ZnS = 1.0 \times 10^{-21}$)

(a) 1.0×10^{-9} M (b) 11×10^{-4} M
(c) 3.3×10^{-2} M (d) 1.1×10^{-2} M

13. Lassaigne's test for the detection of nitrogen will fail in the case of

(a) 
(b) 
(c) $NH_2-NH_2 \cdot HCl$
(d) 

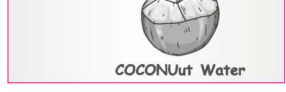
14. Which among the following statements is false?

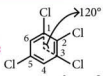
(a) Oil slick in sea water increases D.O. value.
(b) The main reason for river water pollution is industrial and domestic sewage discharge.
(c) Surface water contains a lot of organic matter, mineral nutrients and radioactive materials.
(d) Oil spill in sea water causes heavy damage to fishery.

15. A thermally isolated vessel contains 100 g of water at 0 °C. When air above the water is pumped out, some of the water freezes and some evaporates at 0 °C itself. Calculate the mass of the ice formed such that no water is left in the vessel. (Latent heat of vaporization of water at 0 °C = 2.10×10^6 J/kg and latent heat of fusion of ice = 3.36×10^5 J/kg.)

(a) 91.5 (b) 86.2
(c) 80.6 (d) 75.5

COMIC CAPSULE





1. (c) :

Dipole moments of $\overset{2}{Cl}$ and $\overset{5}{Cl}$ are cancelled.

Dipole moment of the compound is due to $\overset{1}{Cl}$ and $\overset{3}{Cl}$,

$\mu^2 = \mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 \cos\theta$

$= (1.5)^2 + (1.5)^2 + 2 \times 1.5 \times 1.5 \cos 120°$

$\therefore \quad \mu = 1.5$ D

2. (b) : $B_2H_6 + 2NH_3 \rightarrow \underbrace{[H_3N \rightarrow BH_2 \leftarrow NH_3]^+ [BH_4]^-}_{(X)} \xrightarrow{\Delta} \underset{(Y)}{B_3N_3H_6}$

In X, hybridisation state of both B atoms is sp^3.

3. (c)

4. (d) : $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

HCl in 1 drop (0.05 mL) $= \dfrac{0.05 \times 12.0}{1000} = 6 \times 10^{-4}$ mol

Al reacted $= \dfrac{1}{3}$ of HCl $= 2 \times 10^{-4}$ mol

$= 2 \times 10^{-4} \times 27$ g $= 5.4 \times 10^{-3}$ g

Mass $= V \times d$

If, area $= A$

Then, volume $= A \times$ thickness $= \left(A \times \dfrac{0.10}{10}\right) cm^3$

$\therefore \quad$ Mass $= A \times \dfrac{0.10}{10} \times 2.7$

$\therefore \quad A \times \dfrac{0.10}{10} \times 2.7 = 5.4 \times 10^{-3}$

$A = 0.2$ cm^2

5. (a) : % ratio of C : H is 6 : 1 and C : O is 3 : 4 or 6 : 8

$\therefore$ % ratio of C : H : O is 6 : 1 : 8

Element	Percentage	Simplest atomic ratio	Simplest whole no. ratio
C	$\frac{6}{15} \times 100 = 40$	$\frac{40}{12} = 3.33$	1
H	$\frac{1}{15} \times 100 = 6.66$	$\frac{6.66}{1} = 6.66$	2
O	$\frac{8}{15} \times 100 = 53.33$	$\frac{53.33}{16} = 3.33$	1

Thus, the empirical formula is CH_2O

$\therefore \quad$ The compound is HCHO.

6. (b) : The volume of the balloon $= \dfrac{4}{3}\pi r^3$

$= \dfrac{4}{3} \times \dfrac{22}{7} \times \left(\dfrac{21}{2}\right)^3 = 4851$ mL

Volume of the cylinder = 2820 mL

Converting this to volume at NTP :

Volume of H_2 at NTP $= \dfrac{20 \times 2820 \times 273}{300 \times 1}$ mL $= 51324$ mL

After filling, the cylinder will have H_2 equal to its volume = 2820 mL. When the pressure in the cylinder is reduced to one atmosphere, no more H_2 will be released and hence 2820 cm^3 of H_2 will be left in it.

$\therefore \quad$ Actual volume of H_2 for filling balloons

$= 51324 - 2820 = 48504$ mL

Hence no. of balloons to be filled $= \dfrac{48504}{4851} = 10$

7. (d) : 30 mL N/50 HCl = 30 mL N/50 $Ca(HCO_3)_2$

$\equiv$ 30 mL N/50 $CaCO_3 \equiv$ 100 mL tap water

Mass of $CaCO_3$ in 100 mL tap water

$= \dfrac{E \times N \times V}{1000} = \dfrac{50 \times 30}{50 \times 1000} = 0.03$ g

$\Rightarrow$ Hardness = 300 ppm

8. (c) : $O_2 \xrightarrow{h\nu} O + O^*$

$\Delta H^\circ = 498$ kJ mol^{-1}

$= \dfrac{498 \times 10^3}{6.023 \times 10^{23}}$ J molecule^{-1} $= 8.27 \times 10^{-19}$ J molecule^{-1}

Energy required to convert normal (O) into (O^*)

$= 1.853$ eV $= 1.853 \times 1.6 \times 10^{-19} = 2.96 \times 10^{-19}$ J

Total energy $= (8.27 \times 10^{-19}) + (2.96 \times 10^{-19})$

$= 1.123 \times 10^{-18}$ J

Thus, $\lambda = \dfrac{hc}{E} = \dfrac{6.62 \times 10^{-34} \text{ J s} \times 3 \times 10^8 \text{ m s}^{-1}}{1.123 \times 10^{-18} \text{ J}}$

$= 1.768 \times 10^{-7} = 176.8 \times 10^{-9} \approx 177$ nm

EXAM ALERT 2019

Exam	Date
JEE Main I	6th to 20th January
JEE Main II	6th to 20th April
AMU (Engg.)	28th April
NEET	5th May
JEE Advanced	19th May

9. (b) : $CaCO_3 \xrightarrow[(p)]{1000^\circ C} CaO$

$CaO \xrightarrow{H_2O} \underset{\text{Slaked lime}}{Ca(OH)_2} \xrightarrow[\text{compressed}]{K_2O_2} \underset{(r)}{CaO_2} + KOH$

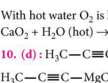
$CaO_2 \xrightarrow[(s)]{H_2O(cold)} Ca(OH)_2 + H_2O_2$

With hot water O_2 is liberated.

$CaO_2 + H_2O$ (hot) $\rightarrow Ca(OH)_2 + O_2$

10. (d) : $H_3C-C\equiv C-\boxed{H + CH_3CH_2}MgCl \rightarrow$

$H_3C-C\equiv C-MgCl + CH_3CH_3$



11. (d) : When EN difference of *X* and H is 1.7 then H*X* is 50% ionic and 50% covalent.

12. (c) : For ZnS not to be precipitated from a solution of Zn^{2+} and Pb^{2+}, $IP_{ZnS} < K_{sp(ZnS)}$

or $[Zn^{2+}][S^{2-}] < K_{sp}$ of ZnS

$[10^{-2}][S^{2-}] < 1.0 \times 10^{-21}$

$\therefore \quad [S^{2-}] < 10^{-19}$ M

So, at $[S^{2-}] = 10^{-19}$ M or less, no precipitation of ZnS will occur.

$H_2S \rightleftharpoons 2H^+ + S^{2-}$

$\therefore \quad [H^+]^2[S^{2-}] = K_{sp(H_2S)} = 1.1 \times 10^{-22}$

$\therefore \quad [H^+]^2_{min}\,[10^{-19}] = 1.1 \times 10^{-22}$

$[H^+]^2_{min} = 11 \times 10^{-4} \qquad \therefore \quad [H^+]_{min} = 3.3 \times 10^{-2}$ M

Thus, if $[H^+] = 3.3 \times 10^{-2}$ M or more, the precipitation of ZnS will not take place and only PbS will precipitate.

13. (c) : $NH_2-NH_2 \cdot HCl$ does not contain C.

14. (a) : Oil slick in sea water decreases D.O. value.

15. (b) : Total mass of the water = $M = 100$ g

Latent heat of vaporization of water at 0 °C

$= L_1 = 21.0 \times 10^5$ J/kg

Latent heat of fusion of ice = $L_2 = 3.36 \times 10^5$ J/kg

Suppose, the mass of the ice formed = m

Then, the mass of water evaporated = $M - m$

Heat lost by the water in freezing = Heat taken by the water in evaporation

Thus, $mL_2 = (M - m)L_1$ or $m = 86.2$ g ◈◈

PUZZLE CORNER

CHEMDOKU

In this puzzle 6 × 6 grid is given, your objective is to fill the digits 1-6 so that each appear exactly once in each row and each column.

Notice that most boxes are part of a cluster. In the upper-left corner of each multibox cluster is a value that is addition, subtraction, multiple or division (as indicated) of its numbers. For example, if that value is 3× for a two-box cluster, you know that only 1 and 3 can go in there. But it is your job to determine which number goes where! A few cluster may have just one box and that is the number that fills that box.

Note : Atomic number of the given element to be considered as your answer.

Clues :

a–	bx		cx		
	dx		ex		
f+			g+		h+
i+	k+	j+			
			lx		
		m+			

(a) It is a non-magnetic element and once called glucine with a symbol of Gl due to its sweet taste.

(b) This element got it name as it can form many coloured compounds, it is both an essential nutrient (in +3 oxidation state) and a highly toxic metal (+6 oxidation state) depending on its valence.

(c) During ancient times, the planet venus had the name of this element when seen right before sunshine.

(d) This element is regularly used in the acute treatment of eclampsia during pregnancy and acute myocardial infarction.

(e) This element is so fundamental to the process of life that the human body contains this more than any other mineral.

(f) When people depressurize too quickly from scuba diving bubble of this gas are formed in the blood stream and other important areas of our body known as decompression sickness.

(g) Yellow street lamps often owe their colour to this element. To achieve a golden hue this metal is mixed with neon gas.

(h) Its compounds are known to stabilize mood, scientist still don't know the exact mechanism for the effect on nervous system.

(i) Its ability to absorb energy is greater than that of steel, which is why the material is used for safety purposes such as fire and blast resistance, bullet proofing and burglary resistant system.

(j) Cave bacteria produces special stalactites called snottites that drips an strong acid of this element. Natural dissolution of minerals by the acid carves out new caves.

(k) In the 1950s during cold war this gas found a new use, purging and pressurizing the rocket engines of nuclear missiles and space missions.

(l) When this gas is inhaled, it is absorbed by the blood and travels through the bloodstream and the heart, along with blood. The pathway can be determined by holding a detection device over the presons's body.

(m) This gas was first used in Word War I as a chemical weapon, but effectiveness of this gas was limited because its strong odor and distinctive colour alerted troops to its presence.

Readers can send their responses at editor@mtg.in or post us with complete address. Solution Senders name with their valuable feedback will be published in next issue. Hope our readers will enjoy solving Chemdoku.

BRUSH UP YOUR CONCEPTS

Class XI

This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at editor@mtg.in. The queries will be entertained by the author.*

SOME BASIC CONCEPTS OF CHEMISTRY | STRUCTURE OF ATOM | CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

SOME BASIC CONCEPTS OF CHEMISTRY

1. Which of the following life saving drugs is effective for helping AIDS victims?
(a) *Cis*-platin (b) Azidothymidine (AZT)
(c) Taxol (d) Novalgin

2. How many significant figures should be present in the answer of the following calculation?

$$\frac{0.0020350 \times 3.103 \times 12}{6.02}$$

(a) 2 (b) 3
(c) 5 (d) Infinite

3. What mass of $CaCO_3$ will react completely with 50 mL of 1.50 M HCl?
(a) 7.50 g (b) 3.75 g (c) 1.875 g (d) 9375 g

4. Average atomic mass of Cu is 63.5. It exists as two isotopes $^{63}_{29}Cu$ and $^{65}_{29}Cu$. What is the percentage abundance of $^{65}_{29}Cu$ in nature?
(a) 12.5% (b) 25% (c) 50% (d) 75%

5. V.D. of a mixture of NO_2 and N_2O_4 is 38.3 at 27 °C. How many moles of NO_2 are present in 500 g mixture?
(a) 1.825 (b) 3.485 (c) 8.125 (d) 2.185

6. A compound contains 12.82% sulphur in it. What is the minimum molecular weight of the compound?
(a) 594.2 g (b) 425.9 g
(c) 249.6 g (d) 954.2 g

7. 50 mL mixture of N_2 and NO was passed over heated copper when the volume of gaseous product obtained was 40 mL. What is the volume of N_2 in the original mixture?
(a) 25.0 mL (b) 30.0 mL
(c) 15.0 mL (d) 35.0 mL

8. 4.0 g of Mg is burnt in 2.0 g of O_2 gas. What is the amount of MgO formed?
(a) 1.0 g (b) 2.5 g (c) 3.5 g (d) 5.0 g

9. What is the molality of a 13% H_2SO_4 solution by mass if its density is 1.02 g cm^{-3}?
(a) 1.255 m (b) 2.155 m
(c) 1.525 m (d) 5.125 m

10. Molarity of a sample of H_2SO_4 is 0.8 M and density is 1.06 g cm^{-3}. What is the mole fraction of H_2SO_4 in the solution?
(a) 0.65 (b) 0.34 (c) 0.045 (d) 0.0145

STRUCTURE OF ATOM

11. What is the mass of electron moving with the velocity of light?
(a) m (b) $\frac{m}{c}$
(c) mc (d) Infinity

12. Mass number of isotones *A* and *B* are 30 and 32 respectively. If atomic number of *A* is 14, what is the atomic number of *B*?
(a) 14 (b) 15 (c) 16 (d) 18

13. Irradiation of a metal with light of frequency 1.04×10^{15} s^{-1} yielded electrons of kinetic energy 2.6×10^{-19} J. The threshold frequency of the metal is ($h = 6.6 \times 10^{-34}$ Js)
(a) 2.33×10^{14} s^{-1} (b) 3.23×10^{14} s^{-1}
(c) 6.47×10^{14} s^{-1} (d) 8.46×10^{14} s^{-1}

*By **R.C. Grover**, having 45+ years of experience in teaching chemistry.

14. If an electron is moving with such a speed that its wavelength equals the distance travelled in one second, the velocity is ($h = 6.6 \times 10^{-34}$ Js)
(a) 7.2×10^{-2} m s^{-1} (b) 2.7×10^{-2} m s^{-1}
(c) 3.0×10^{-5} m s^{-1} (d) 3.0×10^{8} m s^{-1}

15. What is the ratio of shortest wavelength to the longest wavelength of Lyman series of H-atom?
(a) $\frac{1}{2}$ (b) $\frac{4}{3}$ (c) $\frac{3}{4}$ (d) $\frac{2}{1}$

16. What is the value of spin angular momentum of Cr ($Z = 24$)?
(a) $\frac{\sqrt{3}h}{\pi}$ (b) $\frac{\sqrt{2}h}{\pi}$ (c) $\frac{h}{\sqrt{3}.\pi}$ (d) $\frac{h}{\sqrt{2}.\pi}$

17. Which of the following is not correct for $3d^2$?
(a) $n = 3$ (b) $l = 2$
(c) 3 unpaired electrons
(d) Total spin of unpaired electrons $= \frac{1}{2}$

18. The Hamiltonian form of Schrodinger wave equation is
(a) $H\Psi = \hat{E}\Psi$ (b) $\hat{H}\Psi = \hat{E}\Psi$
(c) $\hat{H}\Psi = E\Psi$ (d) $H\Psi = E\Psi$

19. According to Bohr's theory which of the following transition in the hydrogen atom will give rise to the least energetic photon?
(a) $n = 6$ to $n = 1$ (b) $n = 5$ to $n = 4$
(c) $n = 6$ to $n = 5$ (d) $n = 5$ to $n = 3$

20. Which of the following is the energy of a possible excited state of H-atom?
(a) +6.8 eV (b) +13.6 eV
(c) −6.8 eV (d) −3.4 eV

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

21. Who gave the everfirst periodic law?
(a) Dobereiner (b) Newlands
(c) Mendeleev (d) Moseley

22. In which period do the bridge elements fall in Mendeleev's periodic table?
(a) 2nd period (b) 3rd period
(c) 6th period (d) 7th period

23. Which of the following is the correct increasing order of densities of elements of 2nd group?
(a) Be < Mg < Ca < Sr < Ba
(b) Mg < Be < Ca < Sr < Ba
(c) Mg < Ca < Be < Sr < Ba
(d) Ca < Mg < Be < Sr < Ba

24. Electron affinity of Be is similar to
(a) He (b) B (c) Li (d) Na

25. Which of the following is correct for ionic radii?
(a) $F^- > O^{2-} > Na^+$ (b) $Al^{3+} > Mg^{2+} > N^{3-}$
(c) $H^- > H > H^+$ (d) $Na^+ > F^- > O^{2-}$

26. Which of the following is correct for F, Cl, O and N as decreasing oxidising property?
(a) F > Cl > O > N (b) F > O > Cl > N
(c) Cl > F > O > N (d) O > F > N > Cl

27. Electronic configuration of gadolinium Gd ($Z = 64$) is
(a) [Xe] $4f^7 5d^6 6s^2$ (b) [Xe] $4f^7 5d^0 6s^1$
(c) [Xe] $4f^7 5d^1 6s^2$ (d) [Xe] $4f^8 5d^1 6s^2$

28. Moseley plotted atomic number on X-axis and _____ of X-rays on Y-axis.
(a) $\sqrt{\upsilon}$ (b) υ (c) υ^2 (d) $\sqrt{\frac{\upsilon}{Z}}$

29. The total number of elements known till date is
(a) 115 (b) 116 (c) 117 (d) 118

30. Element with atomic number 26 belongs to
(a) 3rd period and 6th group
(b) 4th period and 8th group
(c) 5th period and 4th group
(d) 4th period and 6th group

SOLUTIONS

1. (b)

2. (b) : 3 significant figures, the lowest significant figures in 6.02. 12 is not counted being whole number.

3. (a) : $\underset{100\text{ g}}{CaCO_3} + 2HCl \longrightarrow \underset{73\text{ g}}{CaCl_2} + H_2O + CO_2$

50 mL of 1.50 M HCl $= \frac{50}{1000} \times 1.50 \times 73$ g HCl

73 g HCl needs 100 g $CaCO_3$

$\frac{50 \times 1.50 \times 73}{1000}$ g HCl needs

$= \frac{100 \times 50 \times 1.50 \times 73}{1000 \times 73}$ g $CaCO_3 = 7.5$ g

4. (b) : Let the percentage of $^{65}_{29}Cu = x\%$
Percentage of $^{63}_{29}Cu = 100 - x$

Average mass, $63.5 = \frac{65x}{100} + \frac{63(100 - x)}{100}$

$\Rightarrow \quad x = 25\%$

5. (d) : Let the mass of $NO_2 = x$
Moles of NO_2 + moles of N_2O_4 = Average moles of mixture

$\frac{x}{46}+\frac{500-x}{92}=\frac{500}{2\times 38.3}$; $\frac{2x+500-x}{92}=\frac{500}{76.6}$

$(x+500)=\frac{500\times 92}{76.6}=600.52$

$x = 600.52 - 500 = 100.52$

Moles of $NO_2=\frac{100.52}{46}=2.1852$

6. **(c)** : Minimum molecular mass $=\frac{32\times 100}{12.82}=249.6$ g

7. **(b)** : Let $V_{N_2} = x$ mL; $V_{NO} = (50 - x)$ mL

$$\underset{\text{2 Vol}}{2Cu} + \underset{(50-x)\text{ mL}}{2NO} \longrightarrow 2CuO + \underset{\frac{1}{2}(50-x)\text{ mL}}{\underset{\text{1 Vol}}{N_2}}$$

Final $N_2 : x+\frac{1}{2}(50-x)=40 \Rightarrow x = 30$ mL

8. **(d)** : $\underset{48\text{ g}}{2Mg} + \underset{32\text{ g}}{O_2} \longrightarrow \underset{80\text{ g}}{2MgO}$

48 g Mg needs $O_2 = 32$ g

4.0 g Mg needs $O_2=\frac{4\times 32}{48}=2.67$ g

Given O_2 gas is only 2.0 g, hence, O_2 is limiting reagent.

32 g O_2 gives 80 g MgO

2.0 g O_2 gives $MgO=\frac{80\times 2}{32}=5.0$ g

9. **(c)** : 13% H_2SO_4 by mass $\Rightarrow$ 13 g H_2SO_4 in 87 g H_2O

$\text{Molality}=\frac{\text{moles}}{W_{H_2O}(\text{kg})}=\frac{(13/98)}{87/1000}=1.525$ m

10. **(d)** : 0.8 $MH_2SO_4 \Rightarrow n_{H_2SO_4} = 0.8$; $V_{H_2O} = 1000$ mL

$W_{H_2SO_4} = 0.8 \times 98 = 78.4$ g

$W_{H_2O} = (1000 \times 1.06) - 78.4 = 981.6$ g

$x_{H_2SO_4}=\frac{n_{H_2SO_4}}{n_{H_2SO_4}+n_{H_2O}}=\frac{0.8}{0.8+\frac{981.6}{18}}=0.0145$

11. **(d)** : Mass of electron moving with velocity of light $=\frac{\text{mass of rest}}{\left[1-\left(\frac{v}{c}\right)^2\right]^{1/2}}=\frac{m}{\left[1-\left(\frac{c}{c}\right)^2\right]^{1/2}}=\frac{m}{0}=$ infinity

12. **(c)** : Number of neutrons are equal in A and B

$= 30 - 14 = 16$ (from A)

Number of protons in $B = 32 - 16 = 16$

= Atomic number of B

13. **(c)** : $h\upsilon = h\upsilon_0 + K.E.$

$\upsilon_0 = \upsilon - \frac{K.E.}{h} = 10.4\times 10^{14} - \frac{2.6\times 10^{-19}}{6.6\times 10^{-34}}$

$= 10.4 \times 10^{14} - 3.93 \times 10^{14}$

$= 6.47 \times 10^{14}\ s^{-1}$

14. **(b)** : Distance travelled in one second, *i.e.*, velocity v= wavelength λ

$\lambda=\frac{h}{mv} \Rightarrow v=\frac{h}{m\nu} \Rightarrow v^2=\frac{h}{m} \Rightarrow v=\sqrt{\frac{h}{m}}$

$v=\left[\frac{6.6\times 10^{-34}\text{ Js}}{9.1\times 10^{-31}\text{ kg}}\right]^{\frac{1}{2}}$

$= [0.725 \times 10^{-3}]^{1/2} = (7.25)^{1/2} \times 10^{-2}$ m s^{-1}

$= 2.7 \times 10^{-2}$ m s^{-1}

15. **(c)** : For shortest wavelength,

$\frac{1}{\lambda}=R_H\left[\frac{1}{1^2}-\frac{1}{\infty^2}\right]=R_H \Rightarrow \lambda_{\text{shortest}}=\frac{1}{R_H}$

For longest wavelength,

$\frac{1}{\lambda}=R_H\left[\frac{1}{1^2}-\frac{1}{2^2}\right]=\frac{3R_H}{4}$

$\lambda_{\text{longest}}=\frac{4}{3R_H}$

$\lambda_{\text{shortest}} : \lambda_{\text{longest}}=\frac{1}{R_H}:\frac{4}{3R_H}=\frac{3}{4}$

16. **(a)** : $Cr(Z = 24) : 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Number of unpaired electrons = 6

Spin angular momentum $=\sqrt{\frac{6}{2}\left(\frac{6}{2}+1\right)}\times\frac{h}{2\pi}$

$=\sqrt{3\times 4}\times\frac{h}{2\pi}$

$=\frac{\sqrt{3}h}{\pi}$

17. **(d)** : $3d^7$ is $\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow}\ \boxed{\uparrow}\ \boxed{\uparrow}$ with total spin of unpaired electrons = 3/2.

18. **(c)** **19.** **(c)**

20. **(d)** : $E_n=-\frac{13.6}{n^2}$ eV

For $n = 2$, $E_2=-\frac{13.6}{4}$ eV $= -3.4$ eV

21. **(c)**

22. **(b)** : Na, Mg, Al, ... of third period of Mendeleev's periodic table are called bridge elements.

23. **(d)** **24.** **(a)** **25.** **(c)**

26. **(b)** **27.** **(c)** **28.** **(a)**

29. **(d)**

30. **(b)** : $Fe(Z = 26) : [Ar]\ 3d^6\ 4s^2$

CLASS XI

CBSE DRILL

Chapterwise practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2018-19.

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) Section A: Q.no. 1 to 5 are very short answer questions and carry 1 mark each.
(iii) Section B: Q.no. 6 to 12 are short answer questions and carry 2 marks each.
(iv) Section C: Q.no. 13 to 24 are also short answer questions and carry 3 marks each.
(v) Section D: Q.no. 25 to 27 are long answer questions and carry 5 marks each.
(vi) There is no overall choice. However an internal choice has been provided in two questions of one mark, two questions of two marks, four questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(vii) Use log tables if necessary, use of calculators is not allowed.

Time Allowed : 3 hours Maximum Marks : 70

The *p*-Block Elements (Group 13 to 15) | Some Basic Principles and Techniques of Organic Chemistry

SECTION-A

1. Although diamond is covalent, yet it has very high melting point. Explain.
2. Complete the following reaction :

$$BCl_3 + (C_2H_5)_4NCl \xrightarrow{CHCl_3} ?$$

OR

Mention the optimum conditions for the industrial manufacture of ammonia by Haber's process.

3. Explain that enol form of acetoacetic ester is said to be more volatile than keto form.
4. Molten aluminium bromide is poor conductor of electricity. Explain.
5. Identify the functional groups in the following:

OR

Name two methods which can be safely used to purify aniline.

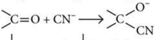
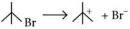
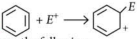
SECTION-B

6. Identify (*A*) and (*B*) in the following reactions :
Colemanite + (*A*) $\longrightarrow Na_2B_4O_7$
$Na_2B_4O_7$ + (*B*) $\longrightarrow H_3BO_3$
7. What is the importance of ultra pure elemental silicon? How is it obtained?

OR

Draw the structures of the following :
(i) PCl_5 in vapour state
(ii) H_3PO_3

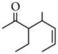
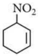
8. Triphenylmethyl cation is very stable and some of its salts can be stored for months. Explain the cause of high stability of this cation.

9. For the following bond cleavages, use curved arrow notation to show the electron flow and classify each as homolysis or heterolysis.
(i) $CH_3O-OCH_3 \longrightarrow CH_3\dot{O} + \dot{O}CH_3$
(ii) 
(iii) 
(iv) 

10. Answer the following :
(i) What are special features of structure of boron?
(ii) Can we prepare anhydrous $AlCl_3$ by heating $AlCl_3.6H_2O$?

OR

Why does gallium undergo disproportionation reactions?

11. Name the following compounds :
(i) 
(ii) 

12. Write the resonance structures of $CH_2=CH-CHO$. Indicate relative stability of the contributing structures in decreasing order.

SECTION-C

13. Explain why
(i) Boron does not form B^{3+} ion
(ii) Boron halides do not exist as dimers while $AlCl_3$ exists as Al_2Cl_6
(iii) PbO_2 is a stronger oxidising agent than SnO_2?

14. Write bond line formulas for : isopropyl alcohol, 2, 3-dimethylbutanal, heptan-4-one.

15. Rationalise the given statements and give chemical reactions :
(i) Lead (II) chloride reacts with Cl_2 to give $PbCl_4$.
(ii) Lead (IV) chloride is highly unstable towards heat.
(iii) Lead is known not to form the iodide, PbI_4.

OR

Give reasons :
(i) White fumes appear around the bottle of anhydrous aluminium chloride.
(ii) Atomic radius of gallium is lower as compared to aluminium.
(iii) Conc. HNO_3 can be transported in aluminium container.

16. How many metamers of 3-pentanone are possible? Write their structures and IUPAC names. Can these be regarded as position isomers as well?

17. Which one of the following is a better nucleophile and why?

$$CH_3-\overset{\overset{O}{\|}}{C}-O^-,\ C_6H_5O^-,\ CH_3CH_2O^-$$

OR

0.35 g of an organic substance was Kjeldahlised and the ammonia obtained was passed into 100 mL of M/10 H_2SO_4. The excess acid required 154 mL of M/10 NaOH for neutralisation. Calculate the percentage of nitrogen in the compound.

18. (i) Define hyperconjugation effect. Explain why $(CH_3)_3C^+$ is more stable than $CH_3CH_2^+$.
(ii) Identify the nucleophiles from the following : R_3N, $>C=O$, R_3C-X, NC^-.

19. Classify the following transformations according to the reaction type :
(i) $H_3C-CH=CH-CH_3 + Br_2 \longrightarrow H_3C-CHBr-CHBr-CH_3$
(ii) $(H_3C)_2C=C(CH_3)_2 + Br_2 \longrightarrow (H_3C)_2C=C(CH_3)CH_2Br + HBr$
(iii) $H_2C=CH-CH_2CH_3 \longrightarrow H_3C-CH=CH-CH_3$
(iv) $C_6H_5CHO + CH_3COCH_3 \longrightarrow C_6H_5CH=CHCOCH_3$
(v) $(CH_3)_3CCl + HO^- \longrightarrow (CH_3)_2C=CH_2$
(vi) $CH_3-\underset{\underset{Ph}{|}}{C}=N-OH + H_3O^+ \longrightarrow CH_3-\underset{\underset{NHPh}{|}}{C}=O$

OR

(i) Can we estimate oxygen in an organic compound?
(ii) An organic compound contains 69% carbon and 4.8% hydrogen, the remainder being oxygen. Calculate the masses of carbon dioxide and water produced when 0.20 g of this substance is subjected to complete combustion.

20. When concentrated sulphuric acid was added to an unknown salt present in a test tube a brown gas

(*A*) was evolved. This gas intensified when copper turnings were added to this test tube. On cooling, the gas (*A*) changed into a colourless solid (*B*).

(i) Identify (*A*) and (*B*).

(ii) Write the structures of (*A*) and (*B*).

(iii) Why does gas (*A*) change to solid on cooling?

21. Compound (*X*) on reduction with $LiAlH_4$ gives a hydride (*Y*) containing 21.72% hydrogen along with other products. The compound (*Y*) reacts with air explosively resulting in boron trioxide. Identify (*X*) and (*Y*). Give balanced reactions involved in the formation of (*Y*) and its reaction with air. Draw the structure of (*Y*).

22. Give reasons for the following:

(i) CCl_4 is immiscible in water, whereas $SiCl_4$ is easily hydrolysed.

(ii) Carbon has a strong tendency for catenation compared to silicon.

23. Discuss the principle of estimation of halogens, sulphur and phosphorus present in an organic compound.

OR

(i) Identify the name of the method and the element estimated by the given methods.

(a) A known mass of an organic compound is heated with fuming HNO_3 in presence of $AgNO_3$.

(b) Organic compound is heated with dry copper oxide in atmosphere of CO_2.

(c) Organic compound is heated with conc. H_2SO_4.

(ii) Suggest methods for the separation of the following mixtures :

(a) A mixture of liquid *A* (b.pt. 365 K) and liquid *B* (b.pt. 356 K).

(b) A mixture of liquid *C* (b.pt. 353 K) and liquid *D* (b.pt. 413 K).

(c) Mixture of calcium sulphate and camphor.

24. Arrange the following in increasing order of the property indicated :

(i) CCl_2, $SiCl_2$, $GeCl_2$, $SnCl_2$ and $PbCl_2$ (stability)

(ii) CO, SiO, SnO, GeO, PbO (basicity)

(iii) SiF_4, $SiCl_4$, SiI_4, $SiBr_4$ (stability)

SECTION-D

25. (i) Suggest a method to purify :

(a) Camphor containing traces of common salt.

(b) Kerosene oil containing water.

(c) A liquid which decomposes at its boiling point.

(ii) Sometimes a red colour is not produced in the Lassaigne's test even if both nitrogen and sulphur are present in the organic compound. Explain.

OR

(i) By mistake, an alcohol (boiling point 97°C) was mixed with a ketone (boiling point 68°C). Suggest a suitable method to separate the two compounds. Explain the reason for your choice.

(ii) Give three points of differences between inductive effect and resonance effect.

26. (i) Complete the following chemical equations :

$Z + LiAlH_4 \longrightarrow X + LiF + AlF_3$

$X + H_2O \longrightarrow Y + H_2$

$X + O_2 \xrightarrow{\Delta} B_2O_3 + H_2O$

(ii) Explain why the following compounds behave as Lewis acids?

(a) BCl_3 (b) $AlCl_3$

OR

Give one method for industrial preparation and one for laboratory preparation of CO and CO_2 each.

27. Answer the following :

(i) Why is a solution of potassium hydroxide used to absorb carbon dioxide evolved during the estimation of carbon present in an organic compound?

(ii) Why is it necessary to use acetic acid and not sulphuric acid for acidification of sodium extract for testing sulphur by lead acetate test?

(iii) Why does SO_3 act as an electrophile?

(iv) What type of organic compounds cannot be Kjeldahlised?

(v) An organic liquid decomposes below its boiling point. How will you purify it?

OR

(i) Write the name of the isomerism shown by the following pairs :

(a) but-1,3-diene and but-1-yne

(b) ethoxybutane and propoxypropane

(ii) Why 3° carbocations are more stable than 1° carbocations?

(iii) Compare inductive and electromeric effects.

(iv) Why CCl_3COOH is a stronger acid than $(CH_3)_3CCOOH$?

SOLUTIONS

1. Diamond has three dimensional network structure involving strong carbon-carbon bonds. These bonds are difficult to break and therefore, the melting point of diamond is very high.

2. $BCl_3 + (C_2H_5)_4\overset{+}{N}Cl \xrightarrow{CHCl_3} [(C_2H_5)_4\overset{+}{N}]BCl_4^-$

OR

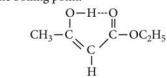
Optimum conditions for the production of ammonia are :

Temperature ~ 700 K

Pressure = about 200 atm (200×10^5 Pa)

Catalyst = iron oxide with small amounts of K_2O and Al_2O_3 (as promoters).

3. It is due to intramolecular H-bonding in enolic form which reduces intermolecular association and lowers the boiling point.



4. Aluminium bromide is predominantly covalent compound. Even in the molten state it does not have ions thus it cannot conduct electricity.

5. —CHO (aldehyde) is the principal functional group. —OH (alcohol) and —O— (ether) are secondary functional groups.

OR

Vacuum distillation and steam distillation.

6. (*A*) is sodium carbonate.

$Ca_2B_6O_{11} + 2Na_2CO_3 \longrightarrow Na_2B_4O_7 + 2NaBO_2 + 2CaCO_3$

(*B*) is either concentrated H_2SO_4 or HCl.

$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$

$Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4H_3BO_3$

7. Ultra pure elemental silicon is used as a semiconductor. It is prepared by the reduction of highly pure silicon tetrachloride ($SiCl_4$) or trichlorosilane ($SiHCl_3$) with dihydrogen.

$SiCl_4 + 2H_2 \xrightarrow{Heat} Si + 4HCl$

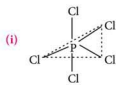
$SiHCl_3 + H_2 \longrightarrow Si + 3HCl$

It can also be prepared by the pyrolysis of SiH_4 in absence of air.

$SiH_4 \xrightarrow{Heat} Si + 2H_2$

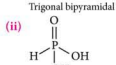
OR

(i)



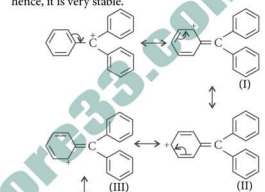
Trigonal bipyramidal

(ii)



Tetrahedral

8. Triphenylmethyl cation is a tertiary carbocation which can show nine possible canonical structures, hence, it is very stable.

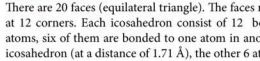


Six more such structures are possible due to resonance in the other two benzene rings

9. (i) $CH_3O\text{-}OCH_3 \xrightarrow{\text{Homolysis}} CH_3\dot{O} + \dot{O}CH_3$ (Free radicals)

(ii) $C{\equiv}O + \overline{C}N \xrightarrow{\text{Heterolysis}} C(O^-)CN$

(iii) $Br \xrightarrow{\text{Heterolysis}} {}^+ + Br^-$ (Carbocation)

(iv) 

Carbocation

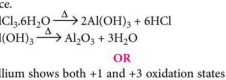
10. (i) It is a symmetrical solid with icosahedral shape. There are 20 faces (equilateral triangle). The faces meet at 12 corners. Each icosahedron consist of 12 boron atoms, six of them are bonded to one atom in another icosahedron (at a distance of 1.71 Å), the other 6 atoms are bonded to atoms in two different icosahedra (at a distance of 2.02 Å).

(ii) No, when $AlCl_3.6H_2O$ is heated, hydrolysis takes place.

$$2AlCl_3.6H_2O \xrightarrow{\Delta} 2Al(OH)_3 + 6HCl$$
$$2Al(OH)_3 \xrightarrow{\Delta} Al_2O_3 + 3H_2O$$

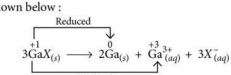
OR

Gallium shows both +1 and +3 oxidation states due to inert pair effect. However, its +3 oxidation state is more stable than +1 oxidation state. Therefore, gallium (+1) undergoes disproportionation to form gallium and more stable +3 gallium ions in aqueous solution as shown below :



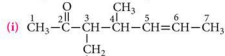
$$3Ga^{+}_{(aq)} \longrightarrow 2Ga_{(s)} + Ga^{3+}_{(aq)}$$

11. (i)



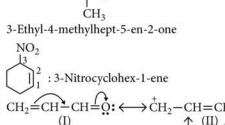
3-Ethyl-4-methylhept-5-en-2-one

(ii)



: 3-Nitrocyclohex-1-ene

12.



Structure (I) is most stable since both C and O atoms have an octet of electrons and none of these atoms carries any charge. Structure (II and III) both involve separation of charge and hence both are less stable than structure (I). However, structure (II) is more stable than structure (III) since it carries a –ve charge on the more electronegative O atom and +ve charge on the less electronegative C atom while in structure (III), the more electronegative O atom carries the +ve charge while the less electronegative C atom carries the –ve charge. Thus, the decreasing order of stability is : I > II > III

13. (i) Boron has three electrons in the valence shell. Because of its small size and high sum of the first three ionization enthalpies (*i.e.*, $\Delta_i H_1 + \Delta_i H_2 + \Delta_i H_3$), boron does not lose all its valence electrons to form B^{3+} ions.

(ii) Boron atom being small in size is unable to accommodate four large sized halogen atoms (except F) around it. However, because of bigger size, Al can easily accommodate four Cl atoms around it. Since in $AlCl_3$, there are only six electrons around Al atom, therefore, it completes its octet by accepting a lone pair of electrons from Cl atom of another $AlCl_3$ molecule. As a result, $AlCl_3$ exists as a chlorine bridged dimeric structure.

(iii) In PbO_2 and SnO_2, both lead and tin are present in +4 oxidation state. But due to stronger inert pair effect, Pb^{2+} ion is more stable than Sn^{2+} ion. In other words, Pb^{4+} ions *i.e.*, PbO_2, is more easily reduced to Pb^{2+} ions than Sn^{4+} are reduced to Sn^{2+} ion. Thus, PbO_2 acts as a stronger oxidising agent than SnO_2.

14. Bond line formula for the given compounds are :

(i)

iso-Propyl alcohol

(ii)

2,3-Dimethylbutanal

(iii)

Heptan-4-one

15. (i) $PbCl_2 + Cl_2 \not\longrightarrow PbCl_4$

Lead is more stable in +2 oxidation state than in +4 state due to inert pair effect. Thus, the reaction is not feasible.

(ii) $PbCl_4 \xrightarrow{\Delta} PbCl_2 + Cl_2$

Pb is more stable in its +2 oxidation state due to inert pair effect. As a result, when subjected to heat, Pb (IV) goes to Pb (II) state.

(iii) $Pb + 2I_2 \not\longrightarrow PbI_4$

I^- is a good reducing agent and therefore, reduces Pb (IV) to Pb (II) easily. That is why, PbI_4 does not exist.

OR

(i) Due to the reaction with moisture in the air, HCl fumes (white fumes) are released.

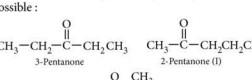
$$Al_2Cl_6 + 6H_2O \longrightarrow 2Al(OH)_3 + 6HCl$$

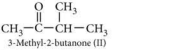
(ii) In between Al and Ga there are ten elements of the first transition series which have electrons in the inner *d*-orbitals. As the *d*-orbitals are large in size, these electrons do not shield the nucleus effectively. Consequently, effective nuclear charge increases in Ga, therefore, it is smaller in size than Al.

(iii) Concentrated nitric acid (HNO_3) renders aluminium passive by forming a protective oxide layer on its surface.

$$2Al + 6HNO_3 \longrightarrow Al_2O_3 + 6NO_2 + 3H_2O$$
(Conc.)

16. Two metamers (I and II) of 3-pentanone are possible :

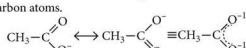




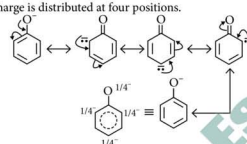
Both these can also be regarded as position isomers of 3-pentanone because they differ in the position of the keto group.

17. $CH_3CH_2O^-$ is a better nucleophile because the –ve charge is concentrated on one oxygen only and the rate is directly proportional to the basicity.

CH_3COO^- is a resonance hybrid of the following structures and the –ve charge is divided on the two carbon atoms.



$C_6H_5O^-$ is not a good nucleophile because the –ve charge is distributed at four positions.



OR

Vol. of M/10 H_2SO_4 taken = 100 mL

Let us first calculate the volume of excess M/10 H_2SO_4 which was neutralised by 154 mL of M/10 NaOH

$N_1V_1 = N_2V_2$

$M = N \times$ basicity $\Rightarrow$ For H_2SO_4, $M = 2N$

Thus, $\frac{M}{10}H_2SO_4 \equiv \frac{N}{5}H_2SO_4$

$154 \text{ mL} \times \frac{N}{10} = \frac{N}{5} \times V_2$

$V_2 = \frac{154}{2}\text{mL} = 77 \text{ mL}$

$\therefore$ Volume of $\frac{M}{10}$ H_2SO_4 left unused = 77 mL

Volume of $\frac{M}{10}$ H_2SO_4 used for neutralisation of NH_3

$= 100 - 77 = 23$ mL

Now, 23 mL of $\frac{M}{10}$ $H_2SO_4 \equiv 2 \times 23$ mL of $\frac{M}{10}$ NH_3

$\equiv 46$ mL of $\frac{M}{10}$ NH_3

Now, 1000 mL of 1 M NH_3 contains nitrogen = 14 g

46 mL of $\frac{M}{10}$ NH_3 contain nitrogen $= \frac{14}{1000} \times \frac{46 \times 1}{10}$

$\therefore$ Percentage of nitrogen $= \frac{14 \times 46 \times 100}{1000 \times 10 \times 0.35} = 18.4\%$

18. (i) When an alkyl group is attached to an unsaturated system such as a double bond or a benzene ring, the order of inductive effect is actually reversed. This effect is called hyperconjugation effect or Baker-Nathan effect.

Hyperconjugation interaction in $(CH_3)_3\overset{+}{C}$ is greater than in $CH_3\overset{+}{C}H_2$ as $(CH_3)_3\overset{+}{C}$ has nine C—H bonds.

(ii) R_3C—X and NC^-

19. (i) Electrophilic addition
(ii) Free radical substitution
(iii) Isomerisation
(iv) Condensation
(v) β-Elimination
(vi) Rearrangement

OR

(i) Yes. But usually it is indirectly estimated by subtracting the sum of percentages of all the elements present in an organic compound from 100.

(ii) % of carbon = 69, % of hydrogen = 4.8
% of oxygen = 100 – (69 + 4.8) = 26.2
Mass of compound = 0.2 g
100 g of compound contains 69 g of C

0.2 g of compound contains $= \frac{69 \times 0.2}{100} = 0.138$ g of C

Also, 12 g of C produces 44 g of CO_2

$\therefore$ 0.138 g of C produces $= \frac{44 \times 0.138}{12} = 0.506$ g of CO_2

100 g of compound contains 4.8 g of H

$\therefore$ 0.2 g of compound contains $= \frac{4.8 \times 0.2}{100}$

$= 0.0096$ g of H

Also, 2 g of H produces 18 g of H_2O

$\therefore$ 0.0096 g of H produces $= \frac{18 \times 0.0096}{2}$ g

$= 0.0864$ g of H_2O

Thus, mass of CO_2 produced = 0.506 g
and mass of H_2O produced = 0.0864 g

20. (i) Light brown fumes of nitrogen dioxide are evolved on heating the nitrate with concentrated H_2SO_4.

$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

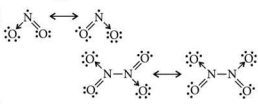
$4HNO_3 \rightarrow 2H_2O + \underset{\text{Brown fumes } (A)}{4NO_2} + O_2$

These fumes intensify when copper turnings are added.

$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

$$\underset{\substack{\text{Brown gas}\\(A)}}{2NO_2} \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \underset{\substack{\text{Colourless solid}\\(B)}}{N_2O_4}$$

(ii)



(iii) Because NO_2 contains odd number of valence electrons and on dimerisation, it is converted to stable N_2O_4 molecule with even number of electrons.

21. $Y + air \longrightarrow B_2O_3$

From this we can guess that Y must be B_2H_6.

$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O + heat$

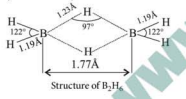
$$\% \text{ of hydrogen in } B_2H_6 = \frac{6}{27.62} \times 100 = 21.72\%$$

$$\underset{X}{} \xrightarrow[\text{(reduction)}]{LiAlH_4} \underset{Y}{B_2H_6}$$

From this we can guess that X is boron trihalide.

$$\underset{X}{4BX_3} + 3LiAlH_4 \longrightarrow \underset{Y}{2B_2H_6} + 3LiX + 3AlX_3$$

(X = Cl or Br)



Structure of B_2H_6

22. (i) CCl_4 is insoluble in water because carbon does not have *d*-orbitals to accommodate the electrons donated by oxygen atom of water molecules. As a result, there is no interaction between CCl_4 and water molecules and hence CCl_4 is insoluble in water. On the other hand, $SiCl_4$ has *d*-orbitals to accommodate the lone pair of electrons donated by oxygen atom of water molecules. As a result, there is a strong interaction between $SiCl_4$ and water molecules. Consequently, $SiCl_4$ undergoes hydrolysis by water to form silicic acid.

$CCl_4 + H_2O \longrightarrow$ No reaction

$SiCl_4 + 4H_2O \longrightarrow \underset{\text{Silicic acid}}{Si(OH)_4} + 4HCl$

(ii) This is due to smaller size and higher electronegativity of carbon atom and unique strength of C — C bonds. Since the atomic size of carbon is much smaller (77 pm) as compared to that of silicon (118 pm), therefore C — C bond dissociation energy is much higher (348 kJ mol^{-1}) than that of Si — Si bond (297 kJ mol^{-1}). Thus, carbon has much higher tendency for catenation than silicon.

23. (i) Estimation of halogens by Carius method : Upon heating an organic compound with fuming HNO_3 in the presence of $AgNO_3$, the halogen present in the compound forms the corresponding silver halide which is collected, filtered, washed, dried and weighed. This is the amount of halogen present in the compound.

Let the mass of organic compound taken = m g

Mass of AgX formed = m_1 g

$$\text{Percentage of halogen} = \frac{\text{Atomic mass of } X \times m_1 \times 100}{\text{Molecular mass of AgX} \times m}$$

(ii) Estimation of sulphur : An organic compound containing sulphur is heated with fuming nitric acid. This oxidises the sulphur to sulphuric acid which is precipitated as $BaSO_4$ upon reaction with $Ba(OH)_2$.

Let the mass of organic compound taken = m g

and the mass of barium sulphate formed = m_1 g

$$\text{Percentage of sulphur} = \frac{32 \times m_1 \times 100}{233 \times m}$$

(iii) Estimation of phosphorus : A known mass of an organic compound is heated with fuming nitric acid so phosphorus present in the compound is oxidised to phosphoric acid. It is precipitated as ammonium phosphomolybdate, $(NH_4)_3PO_4.12MoO_3$, by adding ammonia and ammonium molybdate. Alternatively, phosphoric acid may be precipitated as $MgNH_4PO_4$ by adding magnesia mixture which on ignition yields $Mg_2P_2O_7$.

Let the mass of organic compound taken = m g

and mass of ammonium phosphomolybdate = m_1 g

$$\text{Percentage of phosphorus} = \frac{62 \times m_1 \times 100}{222 \times m}$$

OR

(i) **(a)** Estimation of halogen by Carius method.

(b) Estimation of nitrogen by Dumas method.

(c) Estimation of nitrogen by Kjeldahl's method.

(ii) (a) Fractional distillation because the boiling points of the two liquids differ by just 9°.
(b) Simple distillation since the boiling points of the two liquids are widely apart.
(c) Sublimation

24. (i) The stability of dihalides increases down the group because divalent state becomes more and more stable as we move down the group.
$CCl_2 < SiCl_2 < GeCl_2 < SnCl_2 < PbCl_2$
(ii) Basicity of oxides increases down the group as metallic character increases.
CO < SiO < GeO < SnO < PbO
(iii) Si—*X* bond strength decreases as the size of the halogen increases.
$SiI_4 < SiBr_4 < SiCl_4 < SiF_4$

25. (i) (a) Sublimation : Camphor sublimes while common salt remains as a residue in the china dish.
(b) Since the two liquids are immiscible, the technique of solvent extraction with a separating funnel is used. The mixture is thoroughly shaken and the separating funnel is allowed to stand. Kerosene being lighter than water forms the upper layer while water forms the lower layer. The lower water layer is run off when kerosene oil is obtained.
(c) Distillation under reduced pressure.
(ii) In principle, if the organic compound contains both N and S, sodium thiocyanate should be formed in Lassaigne's test and this should give blood red colouration with $FeCl_3$

$$\underset{\text{(From organic compound)}}{Na + C + N + S} \xrightarrow{\text{Fusion}} \underset{\text{Sod. thiocyanate}}{NaCNS}$$

$$3NaCNS + FeCl_3 \longrightarrow \underset{\substack{\text{Ferric thiocyanate}\\ \text{(Blood red colouration)}}}{Fe(SCN)_3} + 3NaCl$$

However, if blood red colouration is not obtained, it does not necessarily mean that S is absent. This is because in presence of excess of sodium metal, sodium thiocyanate initially formed, decomposes as :

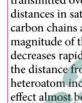
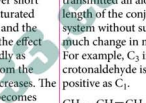
$$2Na + NaCNS \xrightarrow{\Delta} NaCN + Na_2S$$

As a result, blood red colouration is not obtained

OR

(i) If the boiling points of two components of a mixture differ by more than 20°, then these components can be easily separated by simple distillation since at the boiling point of low boiling liquid, the vapours would consist entirely of only low boiling liquid without any contamination of vapours of high boiling liquid and *vice-versa*.

(ii) The main points of difference between inductive and resonance effects are given below :

Inductive effect	Resonance effect
It involves displacement of only σ-electrons and hence occurs only in saturated compounds.	It involves delocalisation of π or *n* (lone pairs) electrons and hence occurs in unsaturated and conjugated systems.
During inductive effect, the electron pair is only slightly displaced towards the more electronegative atom and hence only partial positive and negative charges appear.	During resonance effect, the electron pair is completely transferred and hence full positive and negative charges appear.
Inductive effects are transmitted over short distances in saturated carbon chains and the magnitude of the effect decreases rapidly as the distance from the heteroatom increases. The effect almost becomes negligible beyond three carbon atoms from the heteroatom. 	The resonance effects are transmitted all along the length of the conjugated system without suffering much change in magnitude. For example, C_3 in crotonaldehyde is almost as positive as C_1. 

26. (i) $4BF_3 + 3LiAlH_4 \longrightarrow 2B_2H_6 + 3LiF + 3AlF_3$
$B_2H_6 + 6H_2O \longrightarrow H_3BO_3 + 6H_2$
$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$

(ii) (a) BCl_3 : Boron has 6 electrons in its outermost orbital and has a vacant *p*-orbital. Thus, it is an electron deficient compound hence acts as Lewis acid and accepts a lone pair of electrons.

MONTHLY TUNE UP CLASS XI ANSWER KEY

1.	(a)	**2.**	(c)	**3.**	(d)	**4.**	(a)	**5.**	(c)
6.	(d)	**7.**	(d)	**8.**	(b)	**9.**	(c)	**10.**	(a)
11.	(d)	**12.**	(c)	**13.**	(a)	**14.**	(c)	**15.**	(d)
16.	(d)	**17.**	(b)	**18.**	(b)	**19.**	(b)		
20.	(c,d)	**21.**	(a,b,c,d)			**22.**	(a,c,d)		
23.	(a,b,c,d)	**24.**	(6)	**25.**	(7)	**26.**	(1.344)		
27.	(d)	**28.**	(c)	**29.**	(b)	**30.**	(c)		

(b) $AlCl_3$: $AlCl_3$ is also an electron deficient compound and acts as Lewis acid. It generally forms a dimer to achieve stability.

OR

Preparation of CO :

Lab method : Pure CO is prepared by dehydration of formic acid or oxalic acid with concentrated H_2SO_4 at 373 K.

$$HCOOH \xrightarrow[\text{conc. } H_2SO_4]{373\ K} CO + H_2O$$

Industrial method : CO is prepared by the passage of steam over red hot coke. The mixture of CO and H_2 thus produced is known as water gas or synthesis gas.

$$C_{(s)} + H_2O_{(g)} \xrightarrow{473-1273\ K} \underbrace{CO_{(g)} + H_{2(g)}}_{\text{Water gas}}$$

When air is used instead of steam, a mixture of CO and N_2 is produced, which is called producer gas.

$$2C_{(s)} + O_{2(g)} + 4N_{2(g)} \xrightarrow{1273\ K} \underbrace{2CO_{(g)} + 4N_{2(g)}}_{\text{Producer gas}}$$

Preparation of CO_2 :

Lab method : In the laboratory it is conveniently prepared by the action of dilute acids on carbonates.

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

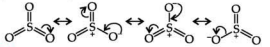
Industrial method : When lime is manufactured by the calcination of limestone ($CaCO_3$), carbon dioxide is obtained as a byproduct.

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

27. (i) KOH reacts with CO_2 to produce K_2CO_3 which is a solid. The K_2CO_3 formed may be weighed and estimated to know the carbon content of the organic compound.

(ii) Sulphuric acid cannot be used for acidification of sodium extract because it would oxidise the sulphur to sulphur dioxide which would not give the black ppt. of PbS, which is otherwise obtained upon reaction with lead acetate.

(iii) SO_3 acts as an electrophile because the highly electronegative oxygen atoms are attached to sulphur atom, hence S becomes electron deficient and acquires a positive charge due to resonance.



(iv) Compounds containing nitrogen atom in the ring and those compounds in which nitrogen is directly linked either to oxygen or to another nitrogen atom such as in nitro ($-NO_2$) and azo ($-N=N-$) compounds.

(v) By distillation under reduced pressure, *i.e.*, vacuum distillation

OR

(i) (a) Functional isomerism :

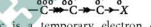
$\underset{\text{But-1, 3-diene}}{H_2C=CH-CH=CH_2}$ and $\underset{\text{But-1-yne}}{HC\equiv C-CH_2CH_3}$

(b) Metamerism :

$\underset{\text{Ethoxybutane}}{CH_3-CH_2-CH_2-CH_2-O-CH_2CH_3}$ and $\underset{\text{Propoxypropane}}{C_3H_7OC_3H_7}$

(ii) Tertiary carbocations have three electron donating alkyl groups. This increases + *I* effect on carbon and reduces the positive charge thereby making it more stable.

(iii) Inductive effect is a permanent effect caused due to more or less electronegative atom/group attached to carbon in an organic compound.

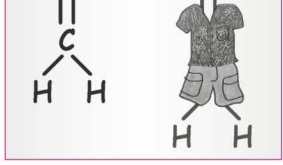


Electromeric is a temporary electron displacement caused in carbon chain due to presence of an external electrophile or nucleophile.

$$R \rightarrow X + OH^- \longrightarrow ROH + X^-$$

(iv) CCl_3COOH is a stronger acid than $(CH_3)_3CCOOH$ due to presence of three electron withdrawing groups (– *I* effect). This reduces electron density of O—H bond and hence, makes it more acidic.

COMIC CAPSULE



Class XI

MONTHLY TUNE UP!

PRACTICE PROBLEMS

These practice problems enable you to self analyse your extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Performance analysis table given at the end will help you to check your readiness.

- Hydrogen
- Redox Reactions

Total Marks : 120 **Time Taken : 60 Min.**

NEET / AIIMS

Only One Option Correct Type

1. Select the incorrect statement among the following.
   (a) Iodometry involves direct reaction of I_2 solution with sodium thiosulphate solution.
   (b) Starch is used as an indicator in iodometric titrations.
   (c) Excess of KI is treated with an oxidising agent to liberate equivalent amounts of I_2.
   (d) Sodium thiosulphate acts as a reducing agent in iodometry.

2. Mass percentage of deuterium in heavy water is
   (a) same as that of protium in water
   (b) 11.1 (c) 20.0
   (d) cannot be predicted.

3. In the following reaction, which species is oxidised?
   $2K[Ag(CN)_2] + Zn \longrightarrow 2Ag + K_2[Zn(CN)_4]$
   (a) $[Ag(CN)_2]^-$ (b) $[Zn(CN)_4]^{2-}$
   (c) Ag (d) Zn

4. On passing hydrogen over heated palladium, the gas
   (a) occludes with palladium
   (b) is oxidised
   (c) is dried
   (d) remains unaffected.

5. Select the compound in which iron is in its lowest oxidation state.
   (a) $K_4[Fe(CN)_6]$ (b) $FeCl_3$
   (c) $Fe(CO)_5$ (d) $Fe_2(SO_4)_3$

6. When zeolite, which is hydrated sodium aluminium silicate, is treated with hard water the sodium ions are exchanged with
   (a) H^+ ions (b) Mg^{2+} ions
   (c) Ca^{2+} ions (d) both Ca^{2+} and Mg^{2+} ions.

7. Hydride ion reacts with water liberating hydrogen gas as follows :
   $$H^- + H_2O \longrightarrow H_2 + OH^-$$
   This reaction indicates that
   (a) hydride ion reduces water to hydroxyl ion.
   (b) hydride ion oxidises water to hydrogen
   (c) hydride ion displaces H^+ ion from water
   (d) hydride ion being stronger base than OH^- takes up H^+ ion from water.

8. For the redox reaction,
   $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$
   correct stoichiometric coefficients of MnO_4^-, $C_2O_4^{2-}$ and H^+ are respectively
   (a) 2, 16, 5 (b) 2, 5, 16
   (c) 16, 5, 2 (d) 5, 16, 2

9. If x g of a metal froms y g of metal chloride, then equivalent weight of metal is
   (a) $\frac{y-x}{35.5x}$ (b) $\frac{35.5y}{y-x}$
   (c) $\frac{35.5x}{y-x}$ (d) $\frac{x}{35.5(y-x)}$

10. Which combination cannot be used for the preparation of hydrogen gas in the laboratory?

I. Zn/conc. H_2SO_4 II. Zn/dil.HNO_3
III. granulated Zn/dil.H_2SO_4
(a) I and II only (b) I, II and III
(c) III only (d) I and III only

11. Which one of the following reactions is the redox reaction?
(a) $Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$
(b) $2S_2O_3^{2-} + 2H_2O \longrightarrow 2SO_4^{2-} + 4H^+$
(c) $BaCl_2 + MgSO_4 \longrightarrow BaSO_4 + MgCl_2$
(d) $Cu_2S + 2FeO \longrightarrow 2Cu + 2Fe + SO_2$

12. The oxygen atom of H_2O_2 which is used for oxidation is bound by
(a) electrovalent bond (b) covalent bond
(c) coordinate bond (d) none of these.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. Assertion: Drinking of heavy water (D_2O) mixed with water (H_2O) could prove fatal.
Reason : There is slower rate of transfer of D^+ compared with that of H^+ ion in acid-base reactions involved in enzyme catalysis.

14. Assertion: In $HClO_4$, chlorine has the oxidation number +7.
Reason : $HClO_4$ (perchloric acid) has two peroxide linkages.

15. Assertion : H_2O_2 has lower b.pt. than water.
Reason : It has stronger dipole-dipole interactions than that shown by water.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. There are three samples of H_2O_2 labelled as 10 vol., 15 vol. and 20 vol. Half litre of each sample are mixed and then diluted with equal volume of water. Calculate volume strength of the resultant solution.
(a) 1.339 (b) 2.68 (c) 5.0 (d) 7.5

17. When SO_2 is passed into an acidified potassium dichromate solution, the oxidation numbers of sulphur and chromium in the final products respectively are
(a) +6, +6 (b) +6, +3
(c) 0, +3 (d) +2, +3

18. 100 mL of 0.01M $KMnO_4$ oxidised 100 mL H_2O_2 in acidic medium. Volume of same $KMnO_4$ required in alkaline medium to oxidise 100 mL of same H_2O_2 will be
(a) $\frac{100}{3}$ mL (b) $\frac{500}{3}$ mL
(c) $\frac{300}{5}$ mL (d) $\frac{200}{5}$ mL

19. The pair of compounds having metals in their highest oxidation states is
(a) MnO_2, $FeCl_3$
(b) MnO_4^-, CrO_2Cl_2
(c) $[Fe(CN)_6]^{4-}$, $[Co(CN)_3]$
(d) $[Ni(CO)_4]$, $[CoCl_4]^-$

More than One Options Correct Type

20. Which of the following reactions do not involve oxidation-reduction?
(a) $2Rb + 2H_2O \longrightarrow 2RbOH + H_2$
(b) $2CuI_2 \longrightarrow 2CuI + I_2$
(c) $NH_4Cl + NaOH \longrightarrow NaCl + NH_3 + H_2O$
(d) $4KCN + Fe(CN)_2 \longrightarrow K_4[Fe(CN)_6]$

21. Which of the following substances catalyse(s) the rate of *ortho-para* conversions of hydrogen?
(a) NO (b) NO_2
(c) O_2 (d) Co^{2+}

22. For the given reaction, which of the following statements is/are correct?
$xCu_3P + yCr_2O_7^{2-} + zH^+ \longrightarrow$
$aCu^{2+} + bH_3PO_4 + cCr^{3+}$
(a) Cu in Cu_3P is oxidised to Cu^{2+} whereas P in Cu_3P is also oxidised to PO_4^{3-}.
(b) Cu in Cu_3P is oxidised to Cu^{2+} whereas P in Cu_3P is reduced to H_3PO_4.
(c) In the conversion of Cu_3P to Cu^{2+} and H_3PO_4, 11 electrons are involved.
(d) The value of x is 6.

23. Among the following, the correct statement is/are
(a) among lanthanides, only europium and ytterbium form ionic hydrides similar to CaH_2
(b) the elements of manganese, iron and cobalt group do not form hydrides
(c) metallic hydrides on heating converts into finely divided powder with liberation of hydrogen
(d) magnesium hydride is an intermediate hydride.

Numerical Value Type

24. Total number of isotopic isomers of hydrogen peroxide containing isotopes of hydrogen only will be equal to

25. In acidic medium, 0.150 M $KMnO_4$ solution (in millilitres) required to react completely with 17.5 mL of 0.150 M $SnCl_2$ solution is

26. To a 25 mL H_2O_2 solution, excess of acidified solution of potassium iodide was added. The iodine liberated required 20 mL of 0.3 N sodium thiosulphate solution. The volume strength of H_2O_2 solution is

Comprehension Type

Hydrogen peroxide is a powerful oxidising agent. It is an electron acceptor in acidic and alkaline mediums.

$H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O$ (in acidic medium)

$H_2O_2 + 2e^- \longrightarrow 2OH^-$ (in alkaline medium)

It can also act as a reducing agent towards powerful oxidising agents.

$H_2O_2 \longrightarrow 2H^+ + O_2 + 2e^-$

In alkaline medium, however, its reducing nature is more effective.

$H_2O_2 + 2OH^- \longrightarrow 2H_2O + O_2 + 2e^-$

27. Which of the following statements about H_2O_2 is not correct?

(a) H_2O_2 is used to clean oil paintings.
(b) H_2O_2 acts as oxidising as well as reducing agent.
(c) It acts as a bleaching agent.
(d) It is highly stable.

28. The bleaching properties of H_2O_2 are due to its

(a) acidic nature (b) basic nature
(c) oxidising nature (d) reducing nature.

Matrix Match Type

29. To 1 mol of $FeO.Fe_2O_3$ excess of $KI_{(aq)}$ is added in acidic medium and the resulting mixture is titrated with hypo using starch as indicator then the correct match of column I with column II will be

	Column I		Column II
(A)	Change in oxidation number of Fe atoms per mol of $FeO.Fe_2O_3$	p.	1
(B)	Change in oxidation number of S-atom in hypo	q.	–2
(C)	Oxidation number of S-atom in the final product	r.	+0.5
(D)	Moles of iodine liberated that is titrated with hypo	s.	+2.5

Codes :

	A	B	C	D
(a)	p	r	q	s
(b)	q	r	s	p
(c)	r	s	p	q
(d)	q	s	r	p

30. Match column I with column II and choose the correct answer using the codes given below :

	Column I		Column II
(A)	$C + H_2O \longrightarrow CO + H_2$	p.	Decomposition reaction
(B)	$PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$	q.	Oxidising nature in alkaline medium
(C)	$2KClO_3 \longrightarrow 2KCl + 3O_2$	r.	Oxidising nature in acidic medium
(D)	$Na_2SO_3 + H_2O_2 \longrightarrow Na_2SO_4 + H_2O$	s.	Bosch process

Codes :

	A	B	C	D
(a)	p	r	q	s
(b)	r	q	p	s
(c)	s	r	p	q
(d)	s	p	r	q

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CHECK YOUR PERFORMANCE

		If your score is	
No. of questions attempted	.....	> 80%	Your preparation is going good, keep it up to get high score.
No. of questions correct	.....	60-80%	Need more practice, try hard to score more next time.
Marks scored in percentage	.....	<60%	Stress more on concepts and revise thoroughly.

CONCEPT MAP

CHEMICAL BONDING

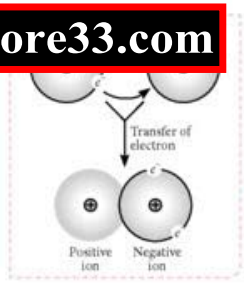
CHEMICAL BONDS

When a chemical bond is formed, the potential energy becomes minimum and the system gains stability.

Primary Bonds

Primary bonds involve sharing or donating electrons between atoms to form a more stable electronic configuration.

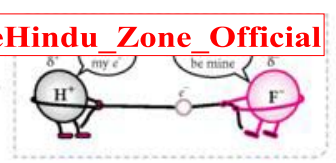
Ionic Bond



The electrostatic bond between two ions formed through the transfer of one or more electrons.

Factors favouring ionic bond formation :

- Low ionisation enthalpy of metal
- High electron gain enthalpy of non-metal
- High lattice enthalpy of ionic compounds
  - Higher charge on ions
  - Smaller size of ions

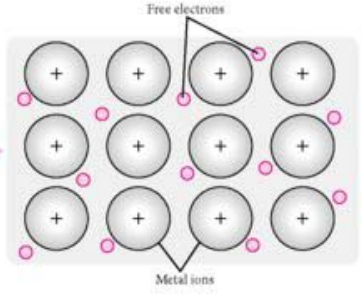


Metallic Bond

Electrostatic attraction between sea of electrons and positive ions.

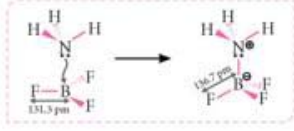
Factors favouring metallic bond formation :

- Low ionization enthalpy.
- Sufficient number of vacant orbitals in valance shell.



Coordinate Bond

In this type of bond sharing electrons are donated by one atom only.

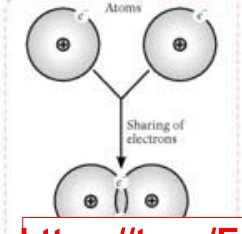


Conditions required for coordinate bond formation :

- One atom must have lone pair of electrons.
- Another atom must have the tendency to take that lone of pair of electrons.

Covalent Bond

Covalent bond formation takes place due to the sharing of electrons.



Factors favourable for covalent bond formation :

- Ionisation enthalpies of combining atoms must be comparable.
- Electron gain enthalpies of combining atoms must be comparable.

Polar Covalent Bond

- Between two atoms with different abilities to attract electrons.
- Molecule itself becomes polar when the shape of the molecule allows a permanent separation of charge.

Non-Polar Covalent Bond

- Between two atoms with same abilities to attract electrons.
- r molecules (of different atoms) can be non-polar
- separated charge cancels each other.

Secondary Bonds

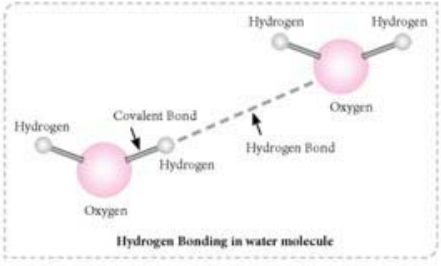
Secondary bonds are not bonds with valance electrons being shared or donated, they are usually formed when an uneven charge distribution occurs.

Hydrogen Bond

Hydrogen bonding occurs when :

- Hydrogen atom is attached to a highly electronegative atom such as F, O and N.
- The highly electronegative atom is small in size.
- The highly electronegative atom has unshared pair of electrons.

Electrostatic attraction of hydrogen covalently bonded to an electronegative atom in one molecule or different molecules.



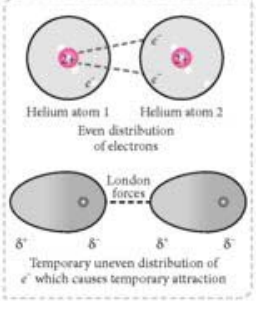
Hydrogen Bonding in water molecule

van der Waals' Forces

It is a general term used for short range electrostatic attractive forces between uncharged molecules.

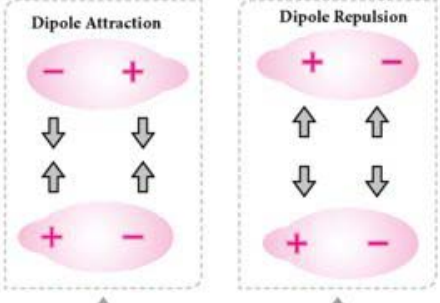
London Forces

- It is a temporary attractive force that results when an electron in two adjacent atom occupy positions that make atoms to form temporary dipole.
- It is also called induced dipole-induced dipole.
- This is the weakest intermolecular force.



Dipole Interactions

- It results when two dipolar molecules interact with each other through space.
- Polar molecules align so that the positive end of one molecule attract the negative end of another molecule.



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Class XII

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UNIT - 6 : Aldehydes, Ketones and Carboxylic Acids

ALDEHYDES AND KETONES

- These are the compounds containing carbonyl group ($>C=O$) having general formula $C_nH_{2n}O$.
- Aldehydes contain carbonyl group attached to either two H-atoms or one H-atom and one C-atom of an alkyl/aryl group.
- In ketones, the carbonyl group is attached to two C-atoms of an alkyl/aryl group.

NOMENCLATURE

- The IUPAC names of open chain aliphatic aldehydes and ketones are derived from the names of the corresponding alkanes by replacing the ending –'e' with –'*al*' and –'*one*' respectively. For example,

$CH_3-CO-CH_2-CH_2-CH_3$

Common name : Methyl *n*-propyl ketone

IUPAC name : Pentan-2-one

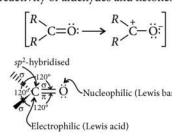
$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CHO$

Common name : Isobutyraldehyde

IUPAC name : 2-Methylpropanal

STRUCTURE

- The C atom of carbonyl group is sp^2 hybridised and forms three σ bonds and one π bond with O atom.
- Carbonyl carbon and three atoms attached to it lie in the same plane with bond angle of 120°, trigonal coplanar structure and π-electron cloud lies above and below of this plane.
- The carbonyl bond is stronger, shorter and more polarised as compared to the double bond in alkenes. As oxygen is more electronegative than carbon, the double bond of carbonyl group is polar and shows dipole moment. Polarisation contributes to the reactivity of aldehydes and ketones.



PREPARATION

Aldehydes and Ketones

Oxidation of alcohols

$$RCH_2OH + [O] \xrightarrow{K_2Cr_2O_7 + H_2SO_4} H_2O + RCHO$$

$$R_2CHOH + [O] \xrightarrow{K_2Cr_2O_7 + H_2SO_4} H_2O + R-\overset{O}{\overset{\|}{C}}-R$$

Oppenauer oxidation

$$R_2CHOH + (CH_3)_2CO \xrightarrow{Al[(CH_3)_3CO]_3} (CH_3)_2CHOH + RCOR$$

Catalytic dehydrogenation of alcohols

$$RCH_2OH \xrightarrow[573\ K]{Cu} RCHO + H_2\uparrow$$

$$R_2CHOH \xrightarrow[573\ K]{Cu} R_2CO + H_2\uparrow$$

Reductive ozonolysis of alkenes

$$RCH{=}CHR + O_3 \xrightarrow[196\ K]{CHCl_3 \text{ or } CCl_4}$$ 

$$\xrightarrow{Zn,\ H_2O} 2RCHO + ZnO$$

Rosenmund reduction

$$RCOCl + H_2 \xrightarrow[\text{boiling xylene}]{Pd\text{-}BaSO_4,\ S} RCHO + HCl$$

Reduction of nitriles

$$RC{\equiv}N \xrightarrow[(ii)\ H_2O]{(i)\ AlH(i\text{-}Bu)_2} RCHO$$

$$RC{\equiv}N \xrightarrow[(ii)\ H_3O^+]{(i)\ R'MgX/\text{dry ether}} RCOR'$$

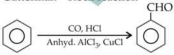
$$RC{\equiv}N \xrightarrow[(ii)\ \text{Ether},\ (iii)\ H_2O]{(i)\ SnCl_2 + HCl} RCHO + NH_4Cl$$

(Stephen reduction)

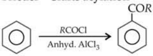
From esters

$$RCOOR \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL\text{-}H,\ 195\ K} RCHO$$

Gatterman–Koch reaction



Friedel–Crafts acylation



From alkynes

$$-C{\equiv}C- \xrightarrow[HgSO_4,\ 333\ K]{\text{dil. } H_2SO_4} RCHO \text{ or } RCOR$$

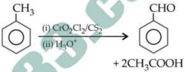
$$-C{\equiv}C- \xrightarrow[H_2O_2/OH^-]{B_2H_6,\ THF} RCHO \text{ or } RCOR$$

Oxidation of 1,2-glycols

$$R-\underset{OH}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH}}-R' + Pb(OOCCH_3)_4 \longrightarrow RCHO + R'CHO + 2CH_3COOH + (CH_3COO)_2Pb$$

$$R_2C(OH)-C(OH)R'_2 \xrightarrow{[O]} RCOR + R'COR'$$

Etard reaction



Oxo process

$$RCH{=}CH_2 + CO + H_2 \xrightarrow[100°C,\ \text{pressure}]{[Co(CO)_4]_2} RCH_2CH_2CHO$$

Wacker process

$$H_2C{=}CH_2 + PdCl_2 + H_2O \xrightarrow[\text{Air or } O_2]{CuCl_2} CH_3CHO + Pd + 2HCl$$

From alkyl halides

$$RCH_2X + (CH_3)_2SO \longrightarrow RCHO + (CH_3)_2S + HX$$

$$R_2CHX + (CH_3)_2SO \longrightarrow R_2CO + (CH_3)_2S + HX$$

From lithium and cadmium salts

$$2RMgX + CdCl_2 \xrightarrow[\text{ether}]{\text{dry}} R_2Cd + 2Mg(X)Cl$$

$$R_2Cd + R'COCl \longrightarrow RCOR' + RCdCl$$

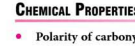
$$R-CO\bar{O}\overset{+}{Li} + CH_3Li \longrightarrow R-\underset{OLi}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_3 \xrightarrow{H^+/H_2O} R-\underset{OH}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_3 \xrightarrow{-H_2O} R-\overset{O}{\overset{\|}{C}}-CH_3$$

Physical Properties

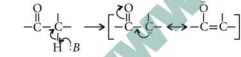
- **Physical state :** Formaldehyde is a pungent smelling gas. Aldehydes and ketones upto eleven carbon atoms are colourless liquids and higher members are solids.
- **Smell :** The odour of lower aldehydes is unpleasant but the odour of higher aldehydes and ketones is pleasant.
- **Boiling point :** The boiling point of aldehydes and ketones rise steadily with increase in molecular mass. Among carbonyl compounds, ketones have slightly higher b.pt. than isomeric aldehydes. This is due to the presence of two electron releasing groups around the carbonyl carbon which makes them more polar.
- **Solubility :** Lower members are soluble in water, whereas higher members are insoluble in water.

Chemical Properties

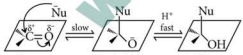
- **Polarity of carbonyl (>C=O) group :** Aldehydes and ketones undergo nucleophilic addition reactions in contrast to alkenes which undergo electrophilic addition reactions.



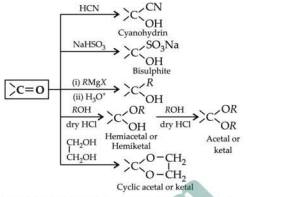
- **Acidity of α-hydrogen atoms :** The acidity of α-hydrogen atoms of carbonyl compounds is due to the strong electron withdrawing effect of the carbonyl group and resonance stabilisation of the conjugate base.



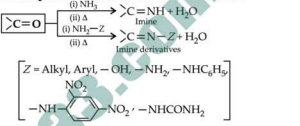
- **Nucleophilic addition reactions :**



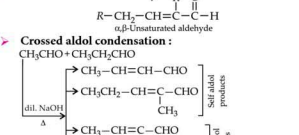
➢ **Reactivity order :**
Aldehydes > Ketones
(steric and electronic reasons)
HCHO > *R*CHO > PhCHO > *R*COR
> *R*COPh > PhCOPh



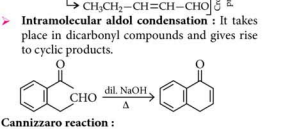
- **Nucleophilic addition - elimination reactions :**



- **Aldol condensation :**
Aldehydes and ketones having at least one α-hydrogen undergo aldol condensation.



➢ **Crossed aldol condensation :**



➢ **Intramolecular aldol condensation :** It takes place in dicarbonyl compounds and gives rise to cyclic products.

- **Cannizzaro reaction :**
It takes place in aldehydes which do not have α-hydrogen atoms.

$$HCHO + HCHO \xrightarrow[\Delta]{\text{conc. KOH}} \underset{\text{Methanol}}{CH_3OH} + \underset{\text{Potassium formate}}{HCOO^-K^+}$$
Formaldehyde

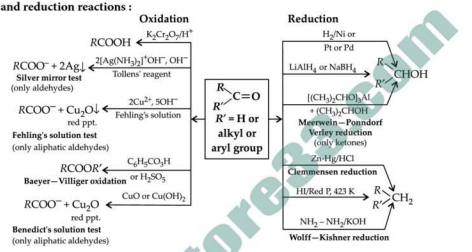
➢ **Crossed Cannizzaro reaction :**

$$\underset{\text{Benzaldehyde}}{C_6H_5-\overset{O}{\overset{\|}{C}}-H} + \underset{\text{Formaldehyde}}{H-\overset{O}{\overset{\|}{C}}-H} \xrightarrow[\Delta]{\text{Conc. NaOH}} C_6H_5CH_2OH + \underset{\text{Sod. formate}}{HCOO^-Na^+}$$
Benzyl alcohol

➢ **Intramolecular Cannizzaro reaction :** It is given by dialdehydes having no α-hydrogen atoms.

$$\underset{\text{Glyoxal}}{H-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-H} \xrightarrow[(50\%)]{NaOH} H-\underset{H}{\overset{OH}{\overset{|}{C}}}-\overset{O}{\overset{\|}{C}}-ONa \xrightarrow{\text{dil. HCl}} \underset{\text{Glycolic acid}}{HOCH_2-COOH}$$

- **Oxidation and reduction reactions :**



- **Haloform reaction :**

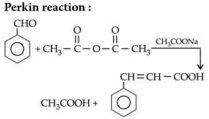
Acetaldehyde, acetone and methyl ketones having CH_3CO- group or compounds having $CH_3CH(OH)-$ group undergo haloform reaction.

$$2NaOH + I_2 \longrightarrow NaI + NaOI + H_2O$$

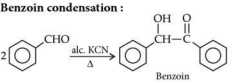
$$RCOCH_3 + 3NaOI \longrightarrow RCOONa + CHI_3\downarrow + 2NaOH$$
(yellow ppt.)

- **Electrophilic substitution reactions :**

- **Perkin reaction :**



- **Benzoin condensation :**



- **Reformatsky reaction :**

$$R-\underset{R}{C}=O + Br-\overset{\alpha}{CH_2}COOC_2H_5 \xrightarrow[\text{reflux}]{Zn/\text{ether}}$$

$$R-\underset{R}{C}(OZnBr)-CH_2-\overset{O}{\overset{\|}{C}}-OC_2H_5 \xrightarrow{H_2O} R-\underset{R}{C}(OH)-CH_2-\overset{O}{\overset{\|}{C}}-OC_2H_5$$

- **Distinction between aldehydes and ketones :**

Tests with	Aldehydes	Ketones
Schiff's reagent	Pink colour	No colour
Fehling's solution	Red precipitate	No precipitate
Tollens' reagent	Black precipitate of silver or silver mirror	No black precipitate or silver mirror

CARBOXYLIC ACIDS

- These are the compounds containing —COOH group having general formula $C_nH_{2n}O_2$.

NOMENCLATURE

- In the IUPAC system, aliphatic carboxylic acids are named by replacing the ending –'*e*' in the name of the corresponding alkane with –'*oic acid*'. In numbering the carbon chain, the carboxylic carbon is numbered one.

$$CH_3—\underset{\displaystyle OH}{\underset{|}{CH}}—COOH$$

Common name : Lactic acid

IUPAC name : 2-Hydroxy propanoic acid

PREPARATION

$$\underset{\text{Primary alcohol}}{RCH_2OH} \xrightarrow[\text{or } K_2Cr_2O_7 + \text{dil. } H_2SO_4]{\text{Oxidation, alk. } KMnO_4,\ H_3O^+ \text{ or } CrO_3\text{–}H_2SO_4} RCOOH$$

$$\underset{\text{Alkyl cyanide}}{RCN} \xrightarrow[\text{Mineral acid } HCl,\ H_2SO_4, \text{ etc.}]{\text{Hydrolysis}} RCOOH$$

$$\underset{\text{Grignard reagent}}{RMgX} \xrightarrow[\text{dry ether}]{CO_2 \text{ (dry ice)}} RCOOH$$

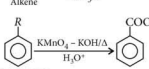
$$\underset{\text{Amide}}{RCONH_2} \xrightarrow[\Delta]{H_3O^+} RCOOH$$

$$\underset{\text{Acyl halide}}{RCOCl} \xrightarrow[\text{or, (i) } OH^-/H_2O \text{ (ii) } H_3O^+]{H_2O} RCOOH$$

$$\underset{\text{Acid anhydride}}{(RCO)_2O} \xrightarrow{H_2O} RCOOH$$

$$\underset{\text{Ester}}{RCOOR'} \xrightarrow{H_3O^+,\ \Delta} RCOOH$$

$$\underset{\text{Alkene}}{RCH{=}CHR} \xrightarrow[\Delta,\ H_3O^+]{KMnO_4/OH^-} 2RCOOH$$



Alkyl benzene

PHYSICAL PROPERTIES

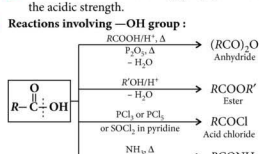
- **Physical state :** The first three acids are colourless, pungent smelling liquids. The acids from butyric to nonanoic are oily liquids. The acids higher than decanoic acid are odourless solids.
- **Boiling point :** Organic acids have high boiling points. It is due to strong van der Waals' forces due to their polar nature. Higher boiling points of acids relative to alcohols are due to the higher degree and strength of hydrogen bonding in them (because of the presence of two oxygen atoms).
- **Solubility :** Carboxylic acids having upto four carbon atoms are miscible in water, after that solubility decreases as the number of carbon atoms increases.

CHEMICAL PROPERTIES

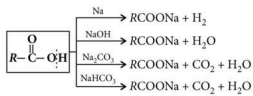
- **Acidic nature :** Carboxylic acids are weaker acids than mineral acids, but they are stronger acids than alcohols and many simple phenols.

$$R-\overset{\displaystyle O}{\overset{\|}{C}}-\underset{\displaystyle OH}{O} + H_2O \rightleftharpoons H_3O^+ + \left[R-\overset{\displaystyle O}{\overset{\|}{C}}-\underset{\displaystyle O^-}{O} \longleftrightarrow R-\underset{\displaystyle O}{\overset{\displaystyle O^-}{C}}=O\right] \equiv R-\overset{\displaystyle O}{\overset{\|}{C}}-\underset{\displaystyle O}{O^-}$$

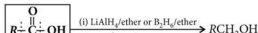
- **Effect of substituents on acidic strength :**
  - Presence of electron withdrawing groups, increases the acidic strength.
  - More the number of electron withdrawing groups, more will be the acidic strength.
  - More is the distance between the carboxyl group and electron withdrawing group, less will be the acidic strength.
  - Presence of electron releasing groups, decreases the acidic strength.
- **Reactions involving —OH group :**



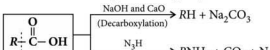
- **Reactions involving proton of —OH group :**



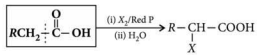
- **Reaction involving $>C=O$ group :**



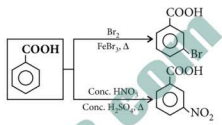
- **Reaction involving —COOH group :**



- **Reaction involving —*R* group :**

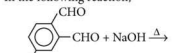


- **Ring substitution in aromatic acids :** —COOH group is deactivating and *meta* directing.

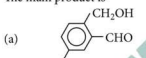


SPEED PRACTICE

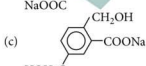
1. In the following reaction,

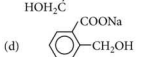


The main product is

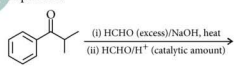
(a) 

(b) 

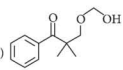
(c) 

(d) 

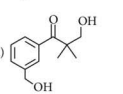
2. The major product of the following reaction sequence is



(a) 

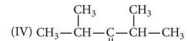
(b) 

(c) 

(d) 

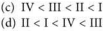
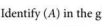
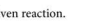
(JEE Advanced 2016)

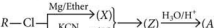
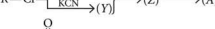
3. Arrange the following in the increasing order of reactivity with NH_3.
(I) CH_2O
(II) CH_3CHO
(III) $CH_3—CO—CH_3$

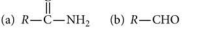
(IV) 

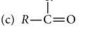
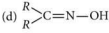
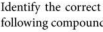
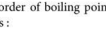
(a) I < II < III < IV
(b) III < IV < I < II
(c) IV < III < II < I
(d) II < I < IV < III

4. Identify (*A*) in the given reaction.

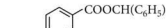
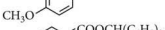
(a) 
(b)
(c) 
(d) 

5. Identify the correct order of boiling points of the following compounds :


(a) 1 > 2 > 3 (b) 3 > 1 > 2
(c) 1 > 3 > 2 (d) 3 > 2 > 1

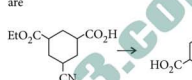
6. 
The number of organic products (*P*) is
(a) 1 (b) 2 (c) 3 (d) 4

7. Of the following, which is the product formed when cyclohexanone undergoes aldol condensation followed by heating?
(a)  (b) 
(c)  (d) 

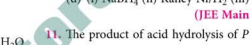
(NEET 2017)

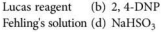
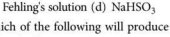
8. Which of the following esters is most likely to undergo unimolecular acid catalysed hydrolysis reaction?
(a) $CH_3CH_2COOC_6H_5$
(b) $CH_3CH_2COOC_2H_5$
(c) 
(d) 

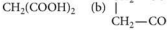
9. The first step in the formation of ester from an alcohol and a carboxylic acid in the presence of conc. H_2SO_4, is
(a) protonation of O-atom of O—H group
(b) protonation of O-atom of >C=O group
(c) formation of resonance structure of acid
(d) removal of α-H from alcohol.

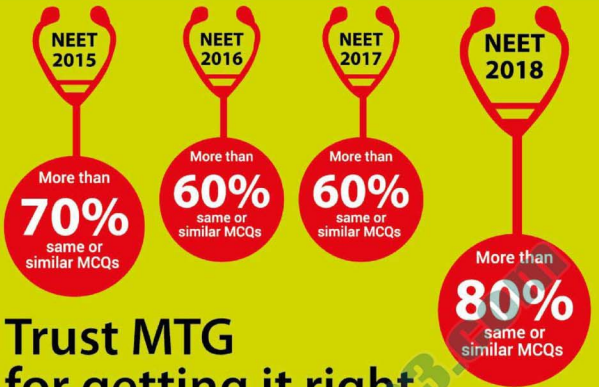
10. The reagent(s) required for the following conversion are

(a) (i) $LiAlH_4$ (ii) H_3O^+
(b) (i) B_2H_6 (ii) DIBAL-H (iii) H_3O^+
(c) (i) B_2H_6 (ii) $SnCl_2/HCl$ (iii) H_3O^+
(d) (i) $NaBH_4$ (ii) Raney Ni/H_2 (iii) H_3O^+

(JEE Main Online 2018)

11. The product of acid hydrolysis of *P* and *Q* can be distinguished by

(a) Lucas reagent (b) 2, 4-DNP
(c) Fehling's solution (d) $NaHSO_3$

12. Which of the following will produce cyclic ketone on heating?
(a) $CH_2(COOH)_2$ (b) 
(c) 
(d) 

13. Consider the following reaction sequence,

(*X*) and (*Y*) are respectively



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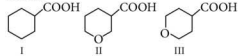
(a) $CH_3—CH(COOH)_2$, $CH_3CH_2—COOH$

(b) $\begin{matrix}COOCH_3\\|\\COOCH_3\end{matrix}$, $CH_3—COOCH_3$

(c) $\begin{matrix}CH_2—COOH\\|\\CH_2—COOH\end{matrix}$, $CH_3—CH_2—COOH$

(d) none of these.

14. The correct order of strengths of the carboxylic acids is



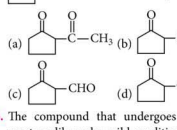
I II III

(a) I > II > III (b) II > III > I

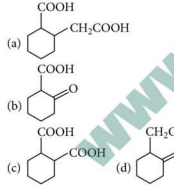
(c) III > II > I (d) II > I > III

(NEET Phase-II 2016)

15. The major product of the following reaction is



16. The compound that undergoes decarboxylation most readily under mild condition is



17. A new carbon-carbon bond formation is possible in

1. Cannizzaro reaction
2. Friedel–Crafts reaction
3. Clemmensen reduction
4. Reimer-Tiemann reaction

(a) 2, 4 (b) 1, 2

(c) 2, 3 (d) 1, 2, 4

18. Identify *B* in the given sequence of reactions :

$CH_3CH_2COOH \xrightarrow[Red\ P]{Cl_2} (A) \xrightarrow{Alc.\ KOH} (B)$

(a) CH_3CH_2COCl (b) CH_3CH_2CHO

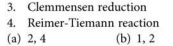
(c) $CH_2{=}CHCOOH$

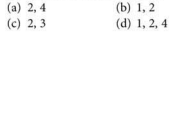
(d) $ClCH_2CH_2COOH$

19. Predict the major organic product (*Y*) in the following reaction.

$BaCO_3 \xrightarrow{HCl} X(gas) \xrightarrow[(C_2H_5)_2O]{CH_3CH_2CH_2MgBr} \xrightarrow{H_3O^+} Y$

20. The major product in the following reaction is





(JEE Advanced 2014)

21. Which of the following will not convert $R—C{\equiv}N$ to $R—CHO$?

(a) (i) $SnCl_2/HCl$ (ii) H_2O/H^+

(b) (i) *R*MgX (ii) H_2O/H^+

(c) (i) $LiAlH_4$ (ii) H_2O/Δ

(d) (i) $AlH(i-Bu)_2$ (ii) H_2O/Δ

22. If 3-hexanone is reacted with $NaBH_4$ followed by hydrolysis with D_2O, the product will be

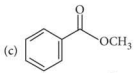
(a) $CH_3CH_2CD(OD)CH_2CH_2CH_3$

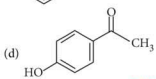
(b) $CH_3CH_2CH(OD)CH_2CH_2CH_3$

(c) $CH_3CH_2CD(OH)CH_2CH_2CH_3$

(d) $CH_3CH_2CH(OH)CH_2CH_2CH_3$

23. A compound of molecular formula $C_8H_8O_2$ reacts with acetophenone to form a single cross-aldol product in the presence of base. The same compound on reaction with conc. NaOH forms benzyl alcohol as one of the products. The structure of the compound is

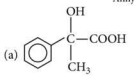
(c) 

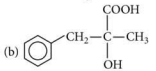
(d) 

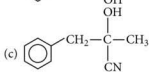
(JEE Main Online 2017)

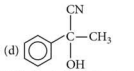
24. In the following set of reactions the product *D* is

$$CH_3COOH \xrightarrow{SOCl_2} A \xrightarrow[\text{Anhy. } AlCl_3]{\text{Benzene}} B \xrightarrow{HCN} C \xrightarrow{HOH} D$$

(a) 

(b) 

(c) 

(d) 

25. Which of the following reactions does not give ethanamide?

(a) $HCHO + NH_3 \xrightarrow{Heat}$

(b) $(CH_3CO)_2O + NH_3 \xrightarrow{Heat}$

(c) $CH_3COBr + NH_3 \xrightarrow{Heat}$

(d) $CH_3COOC_2H_5 + NH_3 \xrightarrow{Heat}$

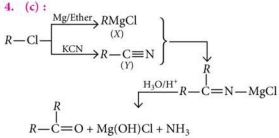
SOLUTIONS

1. (d) : It is Cannizzaro reaction, occurs mainly at *ortho*-position.

2. (a)

3. (c) : Any substance that increases the positive charge on the carbonyl carbon must increase its reactivity towards nucleophilic addition reactions. Steric effect also plays an important role.

4. (c) :



5. (b) : —COOH and —OH group form hydrogen bonds due to which they have high boiling point. —COOH group shows strong hydrogen bonding so it forms cyclic dimer and have more boiling point than —OH group. While —CHO group does not form hydrogen bonds. Thus, the order of boiling point is 3 > 1 > 2.

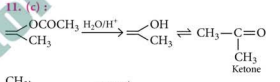
6. (b) : The product oxime (*P*) has *syn* and *anti* forms.

7. (a)

8. (c) : Ester that produces a highly stable carbocation is more likely to undergo unimolecular acid catalysed hydrolysis.

9. (b) **10. (c)**

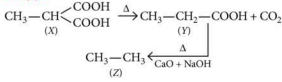
11. (c) :



Ketone (non-reducing) and aldehyde (reducing) can be distinguished by Fehling's solution.

12. (d) : Cyclic ketones are produced by 1,6 and 1, 7-dicarboxylic acids.

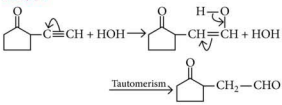
13. (a) :



14. (b) : Acidic strength $\propto -I$ effect. As oxygen is more electron withdrawing, (II) and (III) show greater

– *I* effect than (I). Thus, (I) is least acidic. Out of (II) and (III), (II) is more acidic than (III) as distance of O increases from –COOH group, acidic strength decreases.

15. (b) :



16. (b) : β-Ketoacids undergo decarboxylation easily.

17. (a) : Cannizzaro reaction involves H-transfer and Clemmensen reduction involves the formation of new C—H bond. Friedel—Crafts and Reimer—Tiemann reactions involve the formation of new C—C bonds.

18. (c) : $CH_3CH_2COOH \xrightarrow[Red\ P]{Cl_2}$

$$CH_3CHClCOOH \xrightarrow[-HCl]{Alc.\ KOH} CH_2{=}CHCOOH$$

19. (a) : $Ba\overset{+}{C}O_3 \xrightarrow{HCl} \overset{+}{C}O_2 \xrightarrow[(C_2H_5)_2O]{CH_3CH_2CH_2MgBr}$

$$\xrightarrow{H_3O^+} \overset{+}{C}OOH \quad (Y)$$

20. (d)

21. (b) : Here, '*b*' will produce ketone which may further change to 3° alcohol, if Grignard reagent *RMgX* is taken in excess.

22. (b) : $CH_3CH_2-\overset{O}{\overset{\|}{C}}-CH_2CH_2CH_3 \xrightarrow{NaBH_4}$

3-hexanone

$$CH_3CH_2-\overset{O^-}{\overset{|}{C}}H-CH_2CH_2CH_3 \xrightarrow{D_2O}$$

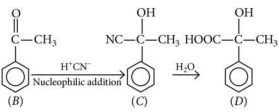
$$CH_3CH_2-\overset{OD}{\overset{|}{C}}H-CH_2CH_2CH_3$$

23. (a)

24. (a) :

$$CH_3COOH \xrightarrow{SOCl_2} CH_3-\overset{O}{\overset{\|}{C}}-Cl \quad (A)$$

$$\xrightarrow[Anhy.\ AlCl_3]{Benzene} \text{Friedel—Crafts acylation}$$



25. (a) : $6HCHO + 4NH_3 \xrightarrow{\Delta} \underset{Urotropine}{(CH_2)_6N_4} + 6H_2O$

For the SCIENTIST in YOU

Cold atmospheric plasma activated water as a prospective disinfectant: The crucial role of peroxynitrite

The socio-economic, environmental and health implications of diseases caused by pathogenic microorganisms and their treatment using conventional antimicrobials are significant. The increasing resistance to antibiotics and detrimental biological side effects of many common antibiotics on human health and that of the ecosystem has driven the search for new cost-effective and highly-efficient sterilization treatments and agents that are more environmentally benign. Plasma activated water (PAW), product of cold atmospheric plasma reacting with water, is a promising broad-spectrum biocidal agent whose biochemical activity is attributed to the presence of a rich diversity of highly reactive oxygen and nitrogen species (RONS). The transient activity of PAW, where PAW reverts to water within days of storage and application, suggests it can become a green alternative to conventional chemical treatment methods, yet the issues of scale up and not fully understood mechanism of activity remain. The antibiotic potential of PAW generated from a plasma jet in a continuous flow reactor and determine the individual and combined contribution of thus-generated reactive chemistries in PAW for organism inactivation has been explored. Treatment of Escherichia coli with PAW led to a more than a 4-log reduction, while exposure to an equivalent single dose of hydrogen peroxide (H_2O_2), nitrate (NO_3^-) or nitrite (NO_2^-) to that found in PAW failed to attain the same level of reduction. Peroxynitrite was identified as a critical bioactive species, particularly under acidic conditions, originating from the synergistic plasma effects (like the reactions of H_2O_2, NO_2^-, NO_3^- and other existing short-lived species like OH radicals in PAW). This research successfully demonstrated the possibility of PAW being an effective environmentally benign disinfectant, the activity of which is closely linked to the generation of peroxynitrite, providing much needed insights into fundamental aspects of PAW chemistry required for optimisation of biochemical activity of PAW and translation of this decontamination strategy into real life applications.

Class XII

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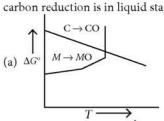
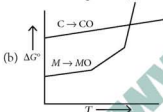
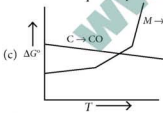
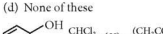
1. In which of the following cases metal obtained by carbon reduction is in liquid state?

(a) 

(b) 

(c) 

(d) None of these

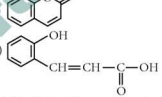
2. 

Product (*Z*) will be

(a) 

(b) 

(c)

(d) 

3. Which of the following has the largest value of dissociation constant K_a?

(a) 

(b) 

(c) 

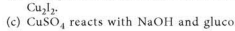
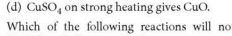
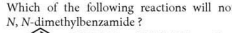
(d) 

4. Given the following limiting molar conductivities at 25 °C, HCl: 426 $\Omega^{-1}cm^2mol^{-1}$; NaCl: 126 $\Omega^{-1}cm^2mol^{-1}$; NaC (sodium crotonate): 83 Ω^{-1} cm^2mol^{-1}. What is the ionization constant of crotonic acid if the conductivity of a 0.001 M crotonic acid (HC) solution is 3.83×10^{-5} $\Omega^{-1}cm^{-1}$?

(a) 1.11×10^{-5} (b) 1.11×10^{-3}

(c) 1.11×10^{-7} (d) 1.11×10^{-2}

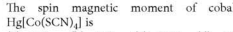
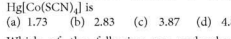
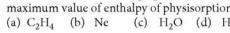
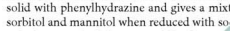
5. Identify the incorrect statement among the following.
(a) $CuSO_4$ reacts with KCl in aqueous solution to give Cu_2Cl_2.
(b) $CuSO_4$ reacts with KI in aqueous solution to give Cu_2I_2.
(c) $CuSO_4$ reacts with NaOH and glucose in aqueous medium to give Cu_2O.
(d) $CuSO_4$ on strong heating gives CuO.

6. Which of the following reactions will not give *N*, *N*-dimethylbenzamide ?
(a) 
(b)
(c) 
(d) 

7. The spin magnetic moment of cobalt in $Hg[Co(SCN)_4]$ is
(a) 1.73 (b) 2.83 (c) 3.87 (d) 4.89

8. Which of the following gas molecules have maximum value of enthalpy of physisorption?
(a) C_2H_4 (b) Ne (c) H_2O (d) H_2

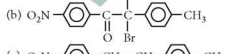
9. An organic compound forms a yellow crystalline solid with phenylhydrazine and gives a mixture of sorbitol and mannitol when reduced with sodium. Which among the following could be the compound?
(a) Fructose (b) Glucose
(c) Mannose (d) Sucrose

10. The major product of the given reaction is

(a) 
(b) 
(c) 
(d) 

11. Vapour pressure of two pure liquids *A* and *B* are 300 and 800 torr respectively at 25 °C. When these two liquids are mixed at this temperature to form a solution in which mole percentage of *B* is 92, then the total vapour pressure is observed to be 0.95 atm. Which of the following is true for this solution?
(a) $\Delta V_{mix} > 0, \Delta H_{mix} > 0$ (b) $\Delta V_{mix} < 0, \Delta H_{mix} < 0$
(c) $\Delta V_{mix} = 0, \Delta H_{mix} = 0$ (d) $\Delta V_{mix} = 0, \Delta H_{mix} < 0$

12. A mineral having formula $Mg_xAl_yO_z$ is found in the spinel structure in which O^{2-} ions constitute *ccp* lattice, Mg^{2+} ions occupy $1/8^{th}$ of the tetrahedral voids and Al^{3+} ions occupy 1/2 of the octahedral voids. Find the total positive charge contained in one unit cell.
(a) +7/4 (b) +6 (c) +2 (d) +8

13. $FeS + H_2SO_4 \longrightarrow A + B\uparrow$
Which of the following statement is incorrect about gas '*B*'?
(a) It produces white ppt. with $FeCl_3$.
(b) It produces black ppt. with $(CH_3COO)_2Pb$.
(c) It produces brown colour solution with sodium nitroprusside.
(d) It decolorises the purple colour of $KMnO_4$.

14. 
A and *B* are
(a) *tert*-butyl benzene, *n*-propyl benzene
(b) *iso*-butyl benzene, *iso*-propyl benzene
(c) *tert*-butyl benzene, *iso*-propyl benzene
(d) *iso*-butyl benzene, *n*-propyl benzene

15. The reaction $A_{(g)} + 2B_{(g)} \rightarrow C_{(g)}$ is an elementary reaction. In an experiment involving this reaction, the initial partial pressures of *A* and *B* are $P_A = 0.40$ atm and $P_B = 1.0$ atm respectively. When pressure of *C* becomes 0.3 atm in reaction, then the rate of the reaction relative to the initial rate is
(a) 0.4 (b) 0.2 (c) 0.04 (d) 0.12

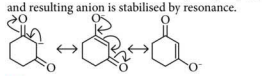
SOLUTIONS

1. **(c)** : When state of reduced metal changes from solid to liquid and then gas, there is steep increase in value of ΔG°. In case of (1), (2) metal obtained is in gaseous state. In case of (3) it is in liquid state.

2. **(c)**

3. **(b)** : 

It contains the most reactive methylene group (*) and resulting anion is stabilised by resonance.



4. **(a)** : $\Lambda_m^{\infty}(HC) = \Lambda_m(HCl) + \Lambda_m(NaC) - \Lambda_m(NaCl)$
$= (426 + 83 - 126)\ \Omega^{-1}cm^2mol^{-1} = 383\ \Omega^{-1}cm^2mol^{-1}$
The molar conductivity of HC,

$$\Lambda_m(HC) = \frac{1000 \times \kappa}{C} = \frac{3.83 \times 10^{-5}}{0.001} \times 1000$$
$$= 38.3\ \Omega^{-1}cm^2mol^{-1}$$

The degree of dissociation,

$$\alpha = \frac{\Lambda_m(HC)}{\Lambda_m^{\infty}(HC)} = \frac{(38.3\ \Omega^{-1}cm^2mol^{-1})}{(383\ \Omega^{-1}cm^2mol^{-1})} = 0.1$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{(10^{-3})(0.1)^2}{1-0.1} = 1.11 \times 10^{-5}$$

5. **(a)** : $2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$ (not given by KCl)

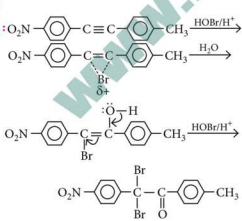
6. **(b)** : $C_6H_5CONH_2 + CH_3MgI \rightarrow C_6H_5CONHMgI + CH_4$

7. **(c)** : $Hg[Co(SCN)_4] \longrightarrow Hg^{2+} + [Co(SCN)_4]^{2-}$
Let oxidation state of cobalt be x.
$x + 4 \times (-1) = -2 \quad \Rightarrow \quad x = +2$
As SCN is a weak field ligand, hence no. of unpaired electrons in Co^{2+} (d^7 electronic configuration) is 3.
So, $\mu_s = \sqrt{3(3+2)} = 3.87$ B.M.

8. **(c)** : The more the liquefiable nature of a gas, the more is the enthalpy of adsorption. Water is more liquefiable.

9. **(a)**

10. **(a)** :



11. **(b)** : According to Raoult's law,
$P_T = (0.08 \times 300 + 0.92 \times 800)$ torr
$= (24 + 736)$ torr $= 760$ torr $= 1$ atm
$P_{exp.} = 0.95$ atm *i.e.*, < 1 atm
Hence, the given solution shows-ve deviation.
$\therefore \quad \Delta H_{mix} < 0$ and $\Delta V_{mix} < 0$

12. **(d)** : In $Mg_xAl_2O_z$, O^{2-} ions are in *ccp* arrangement. Number of atoms in a unit cell of *ccp* = 4. Hence, there are 4 octahdedral voids and 8 tetrahedral voids.
Total positive charge
= charge on Mg^{2+} + charge on Al^{3+}

$$= \frac{1}{8} \times 8 \times 2 + \frac{1}{2} \times 4 \times 3 = 8$$

13. **(c)** : $\underset{(A)}{FeS} + H_2SO_4 \rightarrow \underset{(B)}{FeSO_4} + H_2S \uparrow$

$2FeCl_3 + H_2S \rightarrow 2FeCl_2 + 2HCl + \underset{\text{(White ppt.)}}{S \downarrow}$

$(CH_3COO)_2Pb + H_2S \rightarrow \underset{\text{(Black ppt.)}}{PbS \downarrow} + 2CH_3COOH$

$2KMnO_4 + 3H_2SO_4 + 5H_2S \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5S$

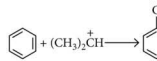
H_2S gives violet colouration with a solution of sodium nitroprusside.

14. **(c)** : $(CH_3)_2CHCH_2Cl \xrightarrow{\text{anhy. } AlCl_3} \underset{\text{1° carbocation}}{(CH_3)_2\overset{+}{C}HCH_2}$

$\xrightarrow[\text{Rearrangement}]{} \underset{\text{3° carbocation}}{(CH_3)_3\overset{+}{C}}$

(*A*)

$(CH_3)_2CH - Cl \xrightarrow{\text{anhy. } AlCl_3} \underset{\text{2° carbocation}}{(CH_3)_2\overset{+}{C}H}$



(*B*)

15. **(c)** :

	$A_{(g)}$	+	$2B_{(g)}$	$\rightarrow$	$C_{(g)}$
At $t = 0$	0.4 atm		1 atm		0 atm
At time t	(0.4 – 0.3) atm		(1 – 0.6)atm		0.3 atm

Since reaction is elementary,
So, rate of reaction w.r.t. *A* and *B* will be of order equal to stoichiometric coefficient.
Rate $= k[A]\ [B]^2$
$\text{Rate}_{(\text{initial})} = k\ [0.4]\ [1]^2$
$\text{Rate}_{(\text{at time } t)} = k\ [0.1][0.4]^2$

$$\frac{r_t}{r_0} = \frac{k[0.1][0.4]^2}{k[0.4][1]} = 0.04$$

BRUSH UP YOUR CONCEPTS

Class XII

This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at editor@mtg.in. The queries will be entertained by the author.*

THE SOLID STATE | SOLUTIONS | ELECTROCHEMISTRY

THE SOLID STATE

1. Which of the following is not correctly matched?

Type of solid	Example
(a) Molecular non-polar solid	Ar
(b) Ionic solid	AlN
(c) Metallic solid	Al
(d) Network solid	SiC

2. Which of the following crystal systems has four possible variations, *i.e.*, Bravais lattices?
(a) Cubic system
(b) Tetragonal system
(c) Orthorhombic system
(d) Hexagonal system

3. How many cubes share an atom or ion present at the corner of a cubic system?
(a) 1 (b) 2 (c) 4 (d) 8

4. What type of void do we get when a void of two dimensional *ABAB* type packing of balls is covered by a ball of another similar layer of balls?
(a) Tetrahedral (b) Octahedral
(c) Hexagonal (d) Body centred

5. If many layers of two dimensional *ABAB* hexagonal packings are stacked one over the other in *ABAB* three dimensional pattern, the crystal system formed is
(a) *fcc* (b) *hcp*
(c) *b.c.* tetragonal (d) *bcc.*

6. In *fcc* system, if we divide a cube into eight equal sub-cubes, where is/are the octahedral void(s) located?
(a) At the body centre
(b) At the edge centres
(c) At the centres of all eight sub-cubes
(d) At all edge centres and the body centre

7. In *fcc* system, we divide a cube into eight equal sub-cubes. Where is/are the tetrahedral void(s) located?
(a) At the body centre
(b) At the edge centres
(c) At the centres of all eight sub-cubes
(d) At all edge centres and the body centre

8. If atoms from one set of alternate faces of *fcc* system are removed, the packing efficiency of the system will be
(a) 68% (b) 74% (c) 55.5% (d) 72.2%

9. If the atom from the centre of a *bcc* system is missing, the packing efficiency of the system will be
(a) 55.5% (b) 74% (c) 68% (d) 52.36%

10. What is the number of atoms present in 200 g of an element having *bcc* structure with edge length 300 pm and density 7.0 g cm^{-3}?
(a) 2.12×10^{23} (b) 2.12×10^{22}
(c) 2.12×10^{24} (d) 2.12×10^{25}

11. Which of the following is not correct for Schottky defect in crystalline NaCl?
(a) Equal number of Na^+ and Cl^- move to interstitial sites.
(b) 1 cm^3 of crystalline NaCl has 10^{22} NaCl units.
(c) NaCl has 10^6 Schottky defects per cm^3.
(d) Per 10^{16} ionic pairs there exists one Schottky defect in crystalline NaCl.

12. Which of the following is the correct ratio of number of Fe^{2+} ions to number of Fe^{3+} ions in $Fe_{0.93}O$ (Wustite)?
(a) 86 : 7 (b) 7 : 86 (c) 73 : 20 (d) 79 : 14

13. Crystals of KCl can be violet or lilac coloured due to

*By **R.C. Grover**, having 45+ years of experience in teaching chemistry.

(a) Schottky defect
(b) metal excess defect
(c) metal deficiency defect
(d) some impurity of violet colour.

14. Conductivity of Si can be increased by
(a) increasing temperature
(b) doping with Ga
(c) doping with Sb
(d) all of these.

15. Which of the following resembles copper in colour and conductivity?
(a) TiO (b) CrO_2 (c) ReO_3 (d) All of these

SOLUTIONS

16. 'Camphor in nitrogen gas' is an example of
(a) gas in gas solution
(b) solid in gas solution
(c) gas in solid solution
(d) liquid in gas solution.

17. What is the value of intercept constant if mole fraction of a gas in solution is plotted *vs* pressure of the gas above the solution?
(a) Zero
(b) 1
(c) Molarity of solution
(d) Experimental pressure

18. At a specific temperature (293 K) values of Henry's law constant (K_H) are given along with gases for their dissolution in water. Which of the following gas would be the most soluble in water at 5 kbar pressure?
(a) He, K_H = 144.97 kbar
(b) H_2, K_H = 69.16 kbar
(c) O_2, K_H = 34. 86 kbar
(d) N_2, K_H = 88.84 kbar

19. Mole fraction of N_2 gas in water at 293 K and 1 kbar pressure is 1.3×10^{-2}. How many millimoles of N_2 gas are present in 1 litre solution?
(a) 0.123 (b) 0.344 (c) 0.611 (d) 0.722

20. A solution containing 0.5 moles of a non-electrolyte and non-volatile solute in one liter water is brought to –3 °C. What mass of water will change to ice? (K_f for water = 1.86 K kg mol^{-1})
(a) 960 g (b) 690 g (c) 600 g (d) 186 g

21. When concentration of solution (g mL^{-1}) is plotted *vs* osmotic pressure (atm) at 300 K, the slope is 4.5×10^{-3} atm mL g^{-1}. What is the molar mass of solute?
(a) 2.1×10^3 g (b) 3.2×10^3 g
(c) 4.5×10^6 g (d) 5.5×10^6 g

22. 2.47 g of an element A_x when dissolved in 50 g of benzene, lowered the freezing point of benzene to 0.4 K. K_f for benzene is 5.12 K kg mol^{-1}. The value of x, for atomic weight of A being 79, is
(a) 2 (b) 4 (c) 6 (d) 8

23. Which of the following will have highest freezing point if one mole per litre solution of each is taken?
(a) Urea (b) KCl (c) $BaCl_2$ (d) $K_3Fe(CN)_6$

24. Osmotic pressure of urea solution at 10 °C is 500 mm. The solution is diluted with temperature raised to 25 °C till its osmotic pressure becomes 131.6 mm. The solution is diluted
(a) 3 times (b) 3.5 times
(c) 4 times (d) 3.8 times.

25. What is the value of '*i*' for H_3PO_3 under ideal condition?
(a) 1 (b) 2 (c) 3 (d) 4

26. 1.8 g of a non-volatile solute was dissolved in 90 g of benzene (b. pt. = 353.3 K, f.pt. = 278.62 K, K_b = 2.53 K kg mol^{-1}, K_f = 5.12 K kg mol^{-1}). If the solution boils at 354.1 K, what is the freezing point?
(a) 271.38 K (b) 277.0 K
(c) 280.24 K (d) 270.0 K

27. Equal masses of non-electrolytes glucose, urea and sucrose are dissolved in 100 mL of water separately at 298 K. How are the osmotic pressures P_1, P_2 and P_3 related to one another?
(a) $P_2 > P_3 > P_1$ (b) $P_3 > P_1 > P_2$
(c) $P_1 > P_2 > P_3$ (d) $P_2 > P_1 > P_3$

28. Which of the following solution is isotonic with 0.06% (*w*/*v*) aqueous solution of urea?
(a) 0.01 M glucose solution
(b) 0.06 M glucose solution
(c) 0.02 M glucose solution
(d) 0.03 M glucose solution

29. Which colligative property is used for finding out the molar mass of a polymer?
(a) ΔT_f (b) ΔT_b (c) π (d) RLVP

30. Vapour pressures of pure *A* and *B* at 298 K are 200 and 60 mmHg respectively. Vapour pressure of solution containing 30 g *A* and 20 g *B* at the same temperature is 90 mmHg. If the molar mass of *A* is 120 g mol^{-1}, the molar mass of *B* is
(a) 15.6 g mol^{-1} (b) 61.5 g mol^{-1}
(c) 21.8 g mol^{-1} (d) 82.1 g mol^{-1}

ELECTROCHEMISTRY

31. A new galvanic cell of E°_{cell} more than E°_{cell} of Daniell cell is connected to the Daniell cell in a manner that the new cell gives electrons to cathode (copper half cell) of Daniell cell, how would the system work?
(a) EMF of Daniell cell will increase.
(b) EMF of Daniell cell will decrease.
(c) Daniell cell will work as electrolytic cell where Zn will deposit on zinc plate while Cu will dissolve from copper plate.
(d) The two cells will not interfere each other.

32. $Ag^+ + e^- \longrightarrow Ag$; $E^{\circ} = +0.80$ V
$Fe^{2+} + 2e^- \longrightarrow Fe$; $E^{\circ} = -0.44$ V
What is the emf of $Fe + 2Ag^+ \longrightarrow Fe^{2+} + 2Ag$?
(a) $(2 \times 0.80) - 0.44$ (b) $0.80 - (-0.44)$
(c) $(2 \times 0.80) - (-0.44)$ (d) $0.44 - (0.80 \times 2)$

33. A galvanic cell has a capacity of doing 212.2714 kJ mol^{-1} of work. If $n = 2$ and $F = 96487$ C mol^{-1}, the EMF of the cell is
(a) 0.55 V (b) 1.10 V (c) 1.65 V (d) 2.20 V

34. A conductivity cell contains electrodes made up of
(a) copper (b) graphite
(c) platinised platinum (d) any of these.

35. 4 S cm^2 mol^{-1} molar conductivity in terms of S m^2 mol^{-1} will be
(a) 4×10^2 (b) 4×10^4 (c) 4×10^{-4} (d) 10^{-4}

36. Which of the following is a 2 – 2 electrolyte?
(a) NaCl (b) 2 moles of KCl
(c) $BaCl_2$ (d) $MgSO_4$

37. For a weak electrolyte which of the following expression is correct for equilibrium constant in terms of molar conductivities at concentration 'C' M and infinite dilution $\wedge$ and $\wedge_{\infty}$ respectively?

(a) $K = \frac{C\wedge_{\infty}}{\wedge(\wedge_{\infty} - \wedge)}$ (b) $K = \frac{C\wedge^2}{\wedge_{\infty}(\wedge_{\infty} - \wedge)}$

(c) $K = \frac{C\wedge_{\infty}}{\wedge(\wedge - \wedge_{\infty})}$ (d) $K = \frac{C\wedge^2_{\infty}}{\wedge(\wedge - \wedge_{\infty})}$

38. In Down's cell molten rock salt is electrolysed by using $CaCl_2$ flux at about 600 – 700°C using graphite anode and steel cathode. Which of the following is collected at steel cathode?
(a) Ca (b) Na (c) H_2 (d) All of these

39. If the pH of HCl in SHE decreases by one unit at 298 K, which of the following is correct?
(a) Potential decreases by 0.59 V.
(b) Potential increases by 0.59 V.

TOP 25 ENGINEERING COLLEGES OF INDIA AND THEIR SELECTION CRITERIA

National Testing Agency, NTA would be conducting the JEE Main 2019 in January 2019 and April 2019. Students who qualify the examination would be able to apply to some of the top engineering colleges in the country. Given below is the list of Top 25 Engineering Colleges of India and the qualifying examination to help you select better. Candidates to please note that in order to be selected in the institutes given below, they are required to get short-listed in the merit list of the respective examinations. Also, students have to qualify the JEE Main examination to be eligible for the JEE Advanced 2019. The ranking provided is based on the National Institutional Ranking Framework, NIRF 2018.

All India Rank	Name of the College/Institute	Qualifying Exam
1	Indian Institute of Technology Madras	JEE Advanced
2	Indian Institute of Technology Bombay	JEE Advanced
3	Indian Institute of Technology Delhi	JEE Advanced
4	Indian Institute of Technology Kharagpur	JEE Advanced
5	Indian Institute of Technology Kanpur	JEE Advanced
6	Indian Institute of Technology Roorkee	JEE Advanced
7	Indian Institute of Technology Guwahati	JEE Advanced
8	Anna University	TANCET
9	Indian Institute of Technology Hyderabad	JEE Advanced
10	Institute of Chemical Technology	MHTCET/ JEE Main
11	National Institute of Technology Tiruchirappalli	JEE Main
12	Jadavpur University	WBJEE
13	Indian Institute of Technology (Indian School of Mines) Dhanbad	JEE Advanced
14	Indian Institute of Technology Indore	JEE Advanced
15	National Institute of Technology Rourkela	JEE Main
16	Vellore Institute of Technology	VITEE
17	Birla Institute of Technology & Science, Pilani	BITSAT
18	Indian Institute of Technology Bhubaneswar	JEE Advanced
19	Indian Institute of Technology (Banaras Hindu University) Varanasi	JEE Advanced
20	Thapar Institute of Engineering and Technology	JEE Main
21	National Institute of Technology Surathkal	JEE Main
22	Indian Institute of Engineering Science and Technology, Shibpur	JEE Main
22	Indian Institute of Technology Ropar	JEE Advanced
23	Indian Institute of Space Science and Technology	JEE Advanced
24	Indian Institute of Technology Patna	JEE Advanced
25	National Institute of Technology Warangal	JEE Main

(c) Potential decreases by 0.059 V.
(d) Potential increases by 0.059 V.

40. What is the pH of the half cell Pt, $H_{2(g)}/H^+$ if $E_{H^+/H_2} = -0.2$ V
(a) 1.19 (b) 2.29 (c) 3.39 (d) 4.49

41. Observe the following cells and compare their emf
$Zn|Zn^{2+}$ (1 M) || Cu^{2+}(1 M) | Cu; E_1
$Zn|Zn^{2+}$(0.1 M) || Cu^{2+} (0.1 M) | Cu; E_2
$Zn|Zn^{2+}$ (10 M) || Cu^{2+}(10 M)|Cu; E_3
(a) $E_1 > E_1 > E_2$ (b) $E_2 > E_1 > E_3$
(c) $E_1 > E_3 > E_2$ (d) $E_1 = E_2 = E_3$

42. What is the value of equilibrium constant for the following reaction?

$$X_{(s)} + 2Y^+_{(aq)} \rightleftharpoons X^{2+}_{(aq)} + 2Y_{(s)}; E^\circ_{cell} = 0.059 \text{ V}$$

(a) 1×10^1 (b) 1×10^2
(c) 2×10^3 (d) 3×10^4

43. Given : (i) $E^\circ_{Cu^{2+}/Cu^+} = x_1$ V,

(ii) $E^\circ_{In^{3+}/In^+} = x_2$ V, (iii) $E^\circ_{In^{2+}/In^+} = x_3$ V,

What is the E°_{cell} for

$$In^{2+} + Cu^{2+} \longrightarrow In^{3+} + Cu^+ \text{ at 298 K ?}$$

(a) $x_1 + x_3 - 2x_2$ (b) $(x_1 + x_3 - 2x_2)/3$
(c) $(x_1 + x_3 + 2x_2)/2$ (d) $x_1 + x_3 - x_2$

44. For a strong electrolyte $\sqrt{C}$ is plotted *vs* molar conductivity, the plot is
(a) straight line with +ve slope
(b) straight line with –ve slope
(c) hyperbola
(d) convex parabola.

45. What is the approximate time in hours for collecting 18 g of magnesium from molten $MgCl_2$ using a current of 10 amperes?
(a) 2 (b) 4 (c) 6 (d) 8

SOLUTIONS

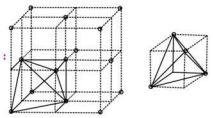
1. (b) : AlN is an example of network solid.

2. (c) **3.** (d)

4. (a) **5.** (b)

6. (d) :

7. (c) :



8. (c) : Alternate faces means two opposite faces.
Number of atoms = 3
For *fcc*, $\sqrt{2} \cdot a = 4r \Rightarrow a = 2\sqrt{2}\, r$
Total volume, $a^3 = 16\sqrt{2} \cdot r^3$

$$\text{Volume occupied} = 3 \times \frac{4}{3}\pi r^3$$

$$\text{Packing fraction} = \frac{3 \times \frac{4}{3}\pi r^3 \times 100}{16\sqrt{2} \cdot r^3} = 55.5\%$$

Alternatively :
For $Z = 4$, packing efficiency = 74%

$$\text{For } Z = 3, \text{ packing efficiency} = \frac{74 \times 3}{4}\% = 55.5\%$$

9. (d) : When an atom from the centre of *bcc* is removed than the left part is simple cubic lattice with packing efficiency 52. 36%.
For simple cubic system, $Z = 1$
$a = 2r \Rightarrow a^3 = 8r^3$ (total volume)

$$\text{Volume occupies} = \frac{4}{3}\pi r^3$$

$$\text{Packing efficiency} = \frac{1 \times \frac{4}{3}\pi r^3 \times 100}{8r^3} = \frac{\pi}{6} \times 100 = 52.36\%$$

10. (c) : Volume of unit cell = $(300 \text{ pm})^3$
$= (300 \times 10^{-10} \text{ cm})^3 = 27 \times 10^{-24} \text{ cm}^3$

$$\text{Volume of 200 g element} = \frac{\text{mass}}{\text{density}} = \frac{200}{7} \text{ cm}^3$$

27×10^{-24} cm^3 = 1 unit cell = 2 atoms (*bcc*)

$$\frac{200}{7} \text{ cm}^3 = \frac{200}{7} \times \frac{2}{27 \times 10^{-24}} \text{ atoms}$$

$$= 2.1164 \times 10^{24} \text{ atoms}$$

Alternatively :

$$\text{Density} = \frac{z \times \text{mass}}{a^3 \times \text{number of atoms}}$$

$$\text{Number of atoms} = \frac{2 \times (200)}{(27 \times 10^{-24}) \times (7)}$$

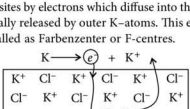
$$= 2.1164 \times 10^{24} \text{ atoms}$$

11. (a)

12. (d) : Let, the number of Fe^{2+} ions be x.
So, the number of Fe^{3+} ions in $Fe_{0.93}O$ will be $(0.93 - x)$
Total charge of x Fe^{2+} ions and $(0.93 - x)Fe^{3+}$ ions will be equal to 2 to balance the charge of O–atom.

$(2x) + (0.93 - x) \times 3 = 2$
$2x + 2.79 - 3x = 2$
$-x = -0.79 \Rightarrow x = 0.79$
So, $0.93 - x = 0.93 - 0.79 = 0.14$
Ratio $Fe^{2+} : Fe^{3+} = 79 : 14$

13. (b) : Loss of Cl^- from lattice points and occupancy of these sites by electrons which diffuse into the crystal, are actually released by outer K–atoms. This electron–site is called as Farbenzenter or F-centres.



14. (d) : In case of semiconductors, the number of electrons that can jump to conduction band, increases by increasing temperature. Doping with an element of 13th group of periodic table converts a semiconductor to p-type (a better conducting) semiconductor. Doping with an element of 15th group of periodic table converts a semiconductor to n–type (a better conducting) semiconductor.

15. (c) : Rhenium oxide ReO_3 is like metallic copper in its conductivity and appearance.

16. (b)

17. (a) : According to Henry's law, $P = K_H x$. This expression does not have intercept constant.

18. (c) : $x\ K_H = P$

At same pressure for all gases, $x \propto \dfrac{1}{K_H}$

Lower the value of K_H, higher will be the mole fraction of gas in solution *i.e.*, solubility.

19. (d) : $x_{N_2} = \dfrac{n_{N_2}}{n_{N_2} + n_{H_2O}}$

$1.3 \times 10^{-5} = \dfrac{n}{55.55}\ [n_{N_2} << n_{H_2O}]$

$n = 1.3 \times 10^{-5} \times 55.55 = 7.22 \times 10^{-4}$ mole
$= 7.22 \times 10^{-1}$ mmole $= 0.722$ mmole

20. (b) : $\Delta T_f = \dfrac{1000 K_f\ W_B}{W_A M_B}$

$\Delta T_f = 3, \dfrac{W_B}{M_B} = 0.5$ mole, $K_f = 1.86$ K kg mol^{-1}

$W_A = \dfrac{1000 \times 1.86 \times 0.5}{3} = 310$ g (liquid water)

Mass of ice = 1000 g (water taken) – 310 g
(water left as liquid) = 690 g

21. (d) : $\tan\theta = \text{slope} = \dfrac{\pi}{C} = 4.5 \times 10^{-3}$

Here, $\pi = 4.5 \times 10^{-3}$ atm

for $C = 1\dfrac{g}{mL} = \dfrac{1 \times 1000}{M}$ Mole L^{-1}

$\pi = C\ R\ T$ (C is in mol L^{-1})

$\dfrac{\pi}{C} = RT \Rightarrow \dfrac{4.5 \times 10^{-3}}{\left(\dfrac{1000}{M}\right)} = 0.0821 \times 300$

$M = \dfrac{0.0821 \times 300 \times 1000}{4.5 \times 10^{-3}} = 5.47 \times 10^6$ g $= 5.5 \times 10^6$ g

22. (d) : $\Delta T_f = \dfrac{1000 K_f\ W_B}{M_B\ W_A}, M_B = 79x$

$79x = \dfrac{1000 \times 5.12 \times 2.47}{0.4 \times 50} = 632.32 \Rightarrow x = \dfrac{632.32}{79} = 8$

23. (a) : Higher the value of i, more is the value of ΔT_f. Here urea solution will have lowest value of ΔT_f and hence highest value of freezing point.

24. (c) : $\pi = \frac{n}{V} RT$

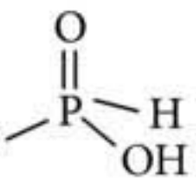
Before dilution, $\frac{500}{760} = \frac{n}{V_1} \times 0.0821 \times 283$ ...(i)

After dilution, $\frac{131.6}{760} = \frac{n}{V_2} \times 0.0821 \times 298$ ...(ii)

Dividing (i) by (ii), $\frac{V_2}{V_1} = \frac{500}{131.6} \times \frac{298}{283} = 4$

$\therefore \quad V_2 = 4V_1$

25. (c) : H_3PO_3 is



It has two replaceable H. Hence, 1 mole of H_3PO_3 will give $2H^+$ and HPO_3^{2-}. So, $i = 3$

26. (b) : $\frac{\Delta T_f}{\Delta T_b} = \frac{\frac{1000 K_f W_B}{W_A M_B}}{\frac{1000 K_b W_B}{W_A M_B}} = \frac{K_f}{K_b}$

$\Delta T_f = \frac{5.12}{2.53} \times (354.1 - 353.3) = 1.62$

Freezing point = (278. 62 – 1.62) K = 277 K

27. (d) : $\pi = \frac{W_B}{M_B} \cdot \frac{RT}{V} \Rightarrow \pi \propto \frac{1}{M_B}$

M_B : Sucrose = 342, glucose = 180 and urea = 60

π : Sucrose = P_3, glucose = P_1, and urea = P_2

Hence, $P_2 > P_1 > P_3$.

28. (a) : Molarity of urea solution

$$= \frac{0.06}{60} \times \frac{1000}{100} = 0.01\,M$$

Two solutions are isotonic under same conditions if their molar concentrations are equal.

29. (c) : Colligative property $\propto \frac{1}{\text{Molar mass}}$

A polymer has very high molar mass and hence ΔT_f, ΔT_b and Relative lowering of vapour pressure will be negligible and not possible to measure. Only π is the measurable colligative property which depends upon the flow of solvent through semipermeable membrane.

30 (c) : $n_A = \frac{30}{120} = \frac{1}{4}; n_B = \frac{20}{x};$

$$n_A + n_B = \frac{1}{4} + \frac{20}{x} = \frac{x+80}{4x}$$

$$\chi_A = \frac{n_A}{n_A + n_B} = \frac{\frac{1}{4}}{\frac{x+80}{4x}} = \frac{x}{x+80}$$

$$\chi_B = 1 - \chi_A = 1 - \frac{x}{x+80} = \frac{x+80-x}{x+80} = \frac{80}{x+80}$$

$P_A^\circ \chi_A + P_B^\circ \chi_B = P_T$

$200 \times \frac{x}{x+80} + 60 \times \frac{80}{x+80} = 90$

$200x + 4800 = 90x + 7200$

$200x - 90x = 7200 - 4800$

$110x = 2400$

$$x = \frac{2400}{110} = 21.8\ \text{g mol}^{-1}$$

31. (c)

32. (b) : E°_{RP} : 0.80 V > –0.44 V

$\Rightarrow$ Ag half cell is cathode and Fe half cell is anode.

$E^\circ_{cell} = E^\circ_C - E^\circ_A$ = 0.80 V – (–0.44 V)

33. (b) : $\Delta G = -nFE$

$$E = -\frac{\Delta G}{nF} = \frac{-212.2714\ \text{kJ mol}^{-1}}{-2 \times 96487\ \text{C mol}^{-1}} = \frac{212271.4\ \text{J}}{192974\ \text{C}} = 1.1\ \text{V}$$

34. (c)

35. (c) : $4\,S\,\text{cm}^2\,\text{mol}^{-1} = 4\,S \left(\frac{\text{cm}^2 \times 10^{-4}\ \text{m}^2}{1\,\text{cm}^2} \right) \text{mol}^{-1}$

$= 4 \times 10^{-4}\ \text{S m}^2\ \text{mol}^{-1}$

36. (d) : $x - y$ type electrolyte means change of cation is $+x$ and that of anion is $-y$.

$MgSO_4$ is 2 – 2 electrolyte : Mg^{2+}, SO_4^{2-}

Quotable Quote

Everybody is a genius .But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid.

Albert Einstein

37. (b) : $\alpha = \dfrac{\Lambda}{\Lambda_\infty}$

$$K = \frac{C\alpha^2}{1-\alpha} = \frac{C\left(\frac{\Lambda}{\Lambda_\infty}\right)^2}{1-\frac{\Lambda}{\Lambda_\infty}} = \frac{C\Lambda^2}{\Lambda_\infty^2\left(\frac{\Lambda_\infty-\Lambda}{\Lambda_\infty}\right)} = \frac{C\Lambda^2}{\Lambda_\infty(\Lambda_\infty-\Lambda)}$$

38. (b) : $NaCl(molten) \rightleftharpoons Na^+ + Cl^-$

At cathode, $Na^+ + e^- \longrightarrow Na$

$CaCl_2$ is used as flux to reduce the melting point of NaCl.

39. (d) : Original $(H^+) = 10^0$, *i.e.*, 1 M

Decrease in pH by 1 unit means new concentration is 10^1 M.

$$E = E^\circ + \frac{0.059}{n}\log[H^+] = 0 + \frac{0.059}{1}\log 10^1 = 0.059\text{ V}$$

40. (c) : $E = E^\circ - \dfrac{0.059}{n}[-\log[H^+]]$

$$-0.2 = 0 - \frac{0.059}{1}\times pH \Rightarrow pH = \frac{0.2}{0.059} = 3.39$$

41. (d) : For equal concentrations of Zn^{2+} and Cu^{2+} ions, n (charge) values being equal the emf will remain the same as is for the standard cell.

42. (b) : $E^\circ_{cell} = \dfrac{0.059}{n}\log K$

$$\log K = \frac{0.059\times 2}{0.059} = 2 = \log 10^2 \Rightarrow K = 10^2$$

43. (a) : $In^{3+} \xrightarrow[n=1]{E_1^\circ = ?} In^{2+} \xrightarrow[n=1]{E_2^\circ = x_3} In^+$

$In^{3+} \longrightarrow In^+$: $E_3^\circ = x_2,\ n = 2$

$$\Delta G_3^\circ = \Delta G_1^\circ + \Delta G_2^\circ$$
$$-(nFE^\circ)_3 = -(nFE^\circ)_1 - (nFE^\circ)_2$$
$$2x_2 = E_1^\circ + x_3$$
$$E_1^\circ = 2x_2 - x_3$$

$$In^{2+} + Cu^{2+} \longrightarrow Cu^+ + In^{3+}$$

$Cu^{2+} \to Cu^+$: gain of e^- (cathode); $In^{2+} \to In^{3+}$: loss of e^- (anode)

$$E^\circ_{cell} = E^\circ_C - E^\circ_A = x_1 - (2x_2 - x_3) = x_1 + x_3 - 2x_2$$

44. (b) : $\Lambda_m = \Lambda_m^\infty - A\sqrt{C}$

[Debye-Huckel-Onsager Equation]

Plot of Λ_m *vs* $\sqrt{C}$ is straight line with –ve slope $(-A)$ and $\Lambda^\infty{}_m$ as intercept.

45. (b) : $\underset{}{Mg^{2+}} + \underset{2F}{2e^-} \longrightarrow \underset{24\text{ g}}{Mg}$

24 g Mg need charge = 2*F* = 2 × 96500 C

18 g Mg needs charge $= (2\times 96500)\times\dfrac{18}{24}$

$$It = Q \Rightarrow t = \frac{2\times 96500}{10}\times\frac{18}{24}\text{ seconds}$$

$$= \frac{3474000}{240}\text{ seconds} = 14475\text{ seconds}$$

$$= \frac{14475}{3600}\text{ hr} = 4.02\text{ hours}$$

CLASS XII

CBSE DRILL

Chapterwise practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2018-19.

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) Section A: Q.no. 1 to 5 are very short answer questions and carry 1 mark each.
(iii) Section B: Q.no. 6 to 12 are short answer questions and carry 2 marks each.
(iv) Section C: Q.no. 13 to 24 are also short answer questions and carry 3 marks each.
(v) Section D: Q.no. 25 to 27 are long answer questions and carry 5 marks each.
(vi) There is no overall choice. However an internal choice has been provided in two questions of one mark, two questions of two marks, four questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(vii) Use log tables if necessary, use of calculators is not allowed.

Time Allowed : 3 hours Maximum Marks : 70

Biomolecules | Polymers | Chemistry in Everyday Life

SECTION-A

1. Based on molecular forces what type of polymer is neoprene?

   OR

   Name the polymer used in making non-stick kitchenwares.

2. Name a drug that acts both as an antipyretic and analgesic.

3. What is the basic structural difference between starch and cellulose?

   OR

   Name two disaccharides which are reducing sugar.

4. Polypropylene contains a large number of chiral carbon atoms. Would you, therefore, expect samples of either isotactic, syndiotactic or atactic polypropylene to rotate the plane of plane polarised light?

5. Classify the following into bactericidal and bacteriostatic antibiotics : Tetracycline, penicillin.

SECTION-B

6. The two strands in DNA are not identical but complimentary. Explain.

7. Why is vitamin A essential to us? Give its important sources.

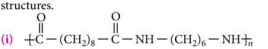
8. Could a copolymer be formed by both addition and condensation polymerisation ? Explain with examples.

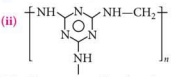
9. What are biodegradable and non-biodegradable detergents ? Give one example of each.

   OR

   Why are cimetidine and ranitidine better antacids than sodium hydrogen carbonate or magnesium hydroxide or aluminium hydroxide?

10. Identify the monomers in the following polymer structures.

(i) 

(ii) 

11. Why do paracetamol preferred over aspirin ?

12. For a sample of DNA from *E. Coli*, the ratio AT/CG is found to be 0.93. If the amount of adenine in its DNA sample is 465000 molecules, calculate the number of molecules of guanine in the sample.

OR

What are hypervitaminosis and avitaminosis?

SECTION-C

13. Answer the following questions :
    (i) Why should medicines not be taken without consulting a doctor?
    (ii) What is meant by 'broad spectrum antibiotics'?
    (iii) What are the main constituents of dettol?

14. A particular sample of polymer contains 200 molecules with molecular mass 10^3, 300 molecules with molecular mass 10^4 and 500 molecules with molecular mass 10^5. Calculate the number average and mass (weight) average molecular mass of the polymer.

OR

What are addition polymers? How are the two types of addition polymers different from each other? Give one example of each type.

15. (i) Write the equilibrium reaction to show the amphoteric behaviour of alanine in H_2O.
    (ii) Calculate the isoelectric pH of alanine. Given pK_{a_1} of cation of alanine = 2.3 and pK_{a_2} of anion of alanine = 9.7.

16. Label the hydrophilic and hydrophobic parts in the following compounds :
    (a) $CH_3(CH_2)_{10}CH_2OSO_3^-Na^+$
    (b) $CH_3(CH_2)_{15}—N^+(CH_3)_3\,Br^-$
    (c) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$

17. What are nylons? How nylon-6, 6 is synthesized? Give its uses.

OR

Distinguish between addition polymers and condensation polymers. Classify the following into addition and condensation polymers :
(i) Polythene (ii) PTFE
(iii) Polybutadiene (iv) Bakelite

18. An optically active amino acid (*A*) can exist in three forms depending upon the pH of the medium. If the molecular formula of (*A*) is $C_3H_7NO_2$, write :
    (a) the structure of the compound in aqueous medium. What are such ions called?
    (b) in which medium will the cationic form of compound (*A*) exist?
    (c) in alkaline medium, towards which electrode, the compound (*A*) migrates in electric field ?

19. Explain mutarotation. Give its mechanism in the case of *D*-glucose.

OR

How does DNA replicate? Describe the mechanism of replication. How is the process responsible for preservation of heredity?

20. What are the advantages of sucralose over the sweetening agents ? Draw its structure.

21. (i) What are the artificial sweetening agents? Give two examples.
    (ii) Name the sweetening agent used in the preparation of sweets for a diabetic patient.
    (iii) Why is aspartame used in cold food and drinks only?

OR

Mention one use of each of the following drugs.
(i) Ranitidine (ii) Paracetamol
(iii) Tincture of iodine

22. Give the synthesis and uses of :
    (i) Polyethylene (ii) Polypropylene
    (iii) Polystyrene

23. What are vitamins ? Classify them into water soluble and insoluble vitamins.

24. (i) Why vitamin C cannot be stored in our body?
    (ii) Name the deficiency diseases resulting from lack of vitamins A and E in the diet.
    (iii) Mention one important function of nucleic acids in our body.

SECTION-D

25. (i) Depict a free radical mode of addition polymerization of isoprene.
    (ii) Explain the differences between polyacrylates and polyesters.

OR

Answer the following :
(i) How does the presence of double bonds in rubber molecules influence their structure and reactivity?

(ii) Discuss the main purpose of vulcanisation of rubber.
(iii) How is dacron obtained from ethylene glycol and terephthalic acid?
(iv) How are polymers different from macromolecules? Explain with example.
(v) Which type of polymerisation gives a polymer containing carbon atoms only in the main chain?

26. (i) How does aspirin help in the prevention of heart attack?
(ii) What type of detergents are used in hair conditioners ?
(iii) Analysis of water in a place shows that the water contains magnesium chloride. The people in that place are advised to use detergents for washing clothes. Why?

OR

(i) List two major classes of anitibiotics with an example of each.
(ii) What do you mean by antimicrobials? What are the sources of these drugs?

27. (i) Give one test to distinguish between glucose and sucrose. Give the relevant equation also.
(ii) What do you observe when you treat a solution of glucose with excess of phenylhydrazine? Name the product. Give the balanced equations for the reaction.

OR

Answer the following :
(i) Enumerate the reactions of glucose which cannot be explained by its open chain structures.
(ii) (a) What type of bonding helps in stabilising of α-helix structure of proteins?
(b) Differentiate between globular and fibrous proteins.

SOLUTIONS

1. Neoprene is elastomer (have weakest intermolecular forces).

OR

Teflon (Polytetrafluoroethene)

2. Aspirin (2-acetoxy benzoic acid) and paracetamol.

3. Starch is a polymer of α-*D*-glucose. It consists of a linear polymer of α-glucose (called amylose) and a branched-chain polymer of α-glucose (called amylopectin).

Cellulose is a linear condensation polymer of β-*D*-glucose.

OR

(i) Maltose (ii) Lactose

4. No, because net rotation is zero since equal amounts of (+) and (–) enantiomers are present.

5. Penicillin (a narrow spectrum antibiotic) is bactericidal and tetracycline (a broad spectrum antibiotic) is bacteriostatic.

6. According to Watson Crick model, the two strands in a DNA molecule are held together by hydrogen bonds between purine base of one strand and pyrimidine base of the other strand and *vice versa*. Because of the difference in the size and geometries of the bases, adenine (A) always pairs with thymine (T), and guanine (G) always pairs with cytosine (C) in a DNA molecule. Due to this base-pairing principle, the sequence of bases on one strand of DNA automatically fixes the sequence of bases on the other strand. Thus, the two strands are not identical but are complimentary to each other.

7. Vitamin A is essential to us because its deficiency in the diet causes hardening of cornea, *i.e.*, xerophthalmia and night blindness. Its important sources are carrots, milk, fish liver oil, eggs, butter etc.

8. Copolymers can be formed both by addition and condensation polymerisation, *e.g.*, styrene butadiene rubber, a copolymer is obtained by addition polymerisation while nylon-6,6 is obtained by condensation polymerisation.

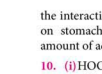
9. The detergents which are not degraded by microorganisms present in the water bodies are called non-biodegradable detergents. Detergents having branching in their hydrocarbon chain are non-biodegradable, e.g., sodium-4-(1, 3, 5, 7-tetramethyloctyl) benzenesulphonate.
The detergents which get degraded by microorganisms present in the water bodies are called biodegradable detergents. The detergents which have no or very little branching in their hydrocarbon chain are biodegradable detergents. Thus detergents based on linear alkyl chain are biodegradable, *e.g.*, sodium lauryl sulphate.

OR

Excessive hydrogen carbonate can make the stomach alkaline and trigger the production of even more acid. Metal hydroxides being insoluble do not increase the pH but these can only cure the symptoms and not the cause, while cimetidine and ranitidine drugs prevent

the interaction of histamine with the receptors present on stomach wall which results in release of lesser amount of acid.

10. (i) $HOOC-(CH_2)_8-COOH$, Sebacic acid; $H_2N-(CH_2)_6-NH_2$, Hexamethylene diamine

(ii)  and 

Melamine; Methanal

11. Paracetamol is usually preferred over aspirin because aspirin gets hydrolysed to salicylic acid in the stomach. The salicylic acid, thus produced may cause ulcer in the stomach walls, from where bleeding may take place. On the other hand, paracetamol do not cause any harm to the stomach walls.

12. Given, $\frac{AT}{CG} = \frac{A+T}{C+G} = 0.93$

As $N_{adenine} = 465000$

So, $N_{thymine} = 465000$

and A + T = 465000 + 465000 = 930000

or, $\frac{930000}{C+G} = 0.93$ or, C + G = 1000000

But, C = G

So, $G = \frac{1000000}{2} = 500000$

OR

Hypervitaminosis refers to a condition of high storage levels of vitamins which can lead to toxic symptoms. Avitaminosis is a kind of disease or illness caused by the deficiency of more than one vitamins.

13. (i) We should not take medicine without consulting doctor because we are not aware of the side effects and reaction of a particular medicine. May be a single medicine could be harmful for our life. So, don't take medicine without consulting a doctor.

(ii) The antibiotic which is effective against a wide range of Gram positive and Gram negative bacteria is known as broad spectrum antibiotic, *e.g.*, chloramphenicol.

(iii) Chloroxylenol and α-terpineol.

14. Number average molecular mass

$$\bar{M}_n = \frac{N_1M_1 + N_2M_2 + N_3M_3}{N_1 + N_2 + N_3}$$

$$= \frac{200\times10^3 + 300\times10^4 + 500\times10^5}{200 + 300 + 500}$$

$$\bar{M}_n = 53200$$

Mass average molecular mass

$$\bar{M}_w = \frac{N_1M_1\times M_1 + N_2M_2\times M_2 + N_3M_3\times M_3}{N_1M_1 + N_2M_2 + N_3M_3}$$

$$= \frac{200\times(10^3)^2 + 300\times(10^4)^2 + 500\times(10^5)^2}{200\times10^3 + 300\times10^4 + 500\times10^5}$$

$$\bar{M}_w = 94552.63$$

OR

Polymers which are formed by the repeated addition reaction of unsaturated monomer molecules are called the addition polymers.

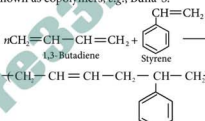
The two types of addition polymers are:

(i) **Homopolymers :** The addition polymers formed by the polymerisation of a single compound are called homopolymers, *e.g.*, polyethene.

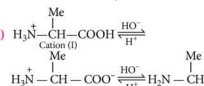
$nCH_2=CH_2 \longrightarrow +CH_2-CH_2+_n$

Ethene; Polythene

(ii) **Copolymers :** The polymers made by addition polymerisation from two different compounds are known as copolymers, *e.g.*, Buna-S.



1,3- Butadiene; Styrene; Styrene butadiene rubber

15. (i) 

Cation (I); Dipolar ion (II); Anion (III)

(ii) pH at isoelectric point (IP)

$$= \frac{pK_{a_1} + pK_{a_2}}{2} = \frac{2.3 + 9.7}{2} = 6$$

The isoelectric point (IP) is the pH at which the amino acid exists only as a dipolar ion (Zwitter ion) with zero net charge.

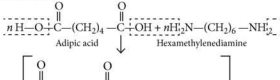
16.

Compound	Hydrophilic part	Hydrophobic part
(a)	$OSO_3^-Na^+$	$CH_3-(CH_2)_{10}-CH_2$
(b)	$N^+(CH_3)_3Br^-$	$CH_3-(CH_2)_{15}-$
(c)	$COO-(CH_2-CH_2O)_n$ CH_2-CH_2-OH	$CH_3(CH_2)_{16}-$

17. Nylons are synthetic polymers which contain polyamide groups (—C(=O)—NH—) which are repeated after a definite interval.

Examples : Nylon-6, 6, Nylon-6 and Nylon-6, 10

Synthesis of Nylon-6, 6 : It is produced by the condensation of adipic acid and hexamethylenediamine molecules.



Uses : (i) In making sheets and fibres.
(ii) Its fibres are used in parachute fabric, cords, ropes, garments, carpets etc.

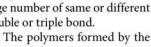
OR

Addition polymers : These polymers are formed by the repeated addition of a large number of same or different monomers possessing double or triple bond.

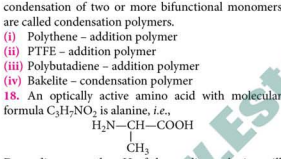
Condensation polymers : The polymers formed by the condensation of two or more bifunctional monomers are called condensation polymers.

(i) Polythene – addition polymer
(ii) PTFE – addition polymer
(iii) Polybutadiene – addition polymer
(iv) Bakelite – condensation polymer

18. An optically active amino acid with molecular formula $C_3H_7NO_2$ is alanine, *i.e.*,

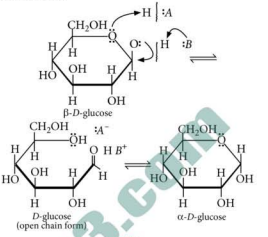


Depending upon the pH of the medium, alanine will exist in the following three forms :



(a) In aqueous medium, alanine exists as zwitter ion (I).
(b) In acidic medium, it will exist in cationic form (II).
(c) In basic medium, it will exist in anionic form (III) thus, will migrate towards anode.

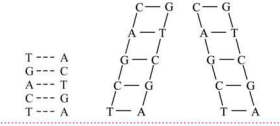
19. The spontaneous change in the specific rotation of an optically active compound with time is called mutarotation. The accepted mechanism of mutarotation of *D*-glucose involves a simultaneous attack by an acid and a base (water is an amphoteric solvent) to yield the open chain aldehyde form, which then recloses to give the other form.



OR

Replication is the process by which a single DNA molecule produces two identical copies of itself, during cell division. During this process, the two strands of the double helix first separate and each separated strand then serves as a template for the synthesis of new strand. Due to specificity of base - pair the sequence in the two new strands is complementary of each other.

In other words, replication leads to the production of two identical copies of DNA from a single parent DNA and a copy of each then passes on to the new cells resulting from cell division. In this way the hereditary effects are transmitted from one cell to another.

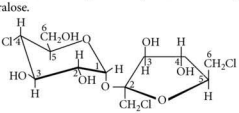


UNSCRAMBLED WORDS

NOVEMBER 2018

1-d- ISODESMIC	2-i- SINTERING
3-e- AUTACOID	4-h- HYPERON
5-a- HIRUDIN	6-c- TUNNELING
7-b- POURBAIX	8-j- PROCION
9-g- UMPOLUNG	10-f- SIDEROPHORE

20. Sucralose is derived from sucrose and is nearly 600 times sweeter than sugar. It was discovered in 1976 and got approved as artificial sweetner by FDA in 1998. It is a very effective sweetner having following advantages :
(1) It is very stable even at high temperature, therefore its sweetness is maintained in food even after using high temperature food processing.
(2) It does not have any calorific value and does not promote tooth decay.
(3) The average daily intake of sucralose is 2.3 mg/kg of body weight, which is a very low amount in comparision to acceptable daily intake of 15 mg/kg sucralose.



21. (i) The chemicals that give sweetness to the food but do not add any calorie to our body are called artificial sweetening agents. *e.g.*, saccharine, aspartame.
(ii) Any artificial sweetening agent like aspartame, alitame, etc., can be added to the food consumed by diabetic patient.
(iii) Aspartame is decomposed at cooking temperature, hence its use is limited to cold food and cold drinks only.

OR

(i) Ranitidine is used as an antacid.
(ii) Paracetamol is used to bring down the body temperature during high fever.
(iii) Tincture of iodine is used as an antiseptic. It is 2-3% solution of iodine in alcohol and water.

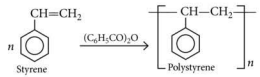
22. (i) Polythylene or polyethene : When ethylene is polymerized at 480 K under pressure in presence of 0.1% oxygen, polyethylene is obtained.

$$n CH_2 = CH_2 \xrightarrow[0.1\%\ \text{oxygen}]{480\ K,\ 150\ \text{atm}} \leftarrow CH_2 - CH_2 \rightarrow_n$$

It is used in making carry bags, milk cartons, toys and electrical insulation.
(ii) Polypropylene : When propylene is passed through *n*-hexane containing Ziegler-Natta catalyst (mixture of $TiCl_4$ and triethyl aluminium), polypropylene is formed.

$$n CH_3 - CH = CH_2 \xrightarrow[TiCl_4]{Al(C_2H_5)_3} \left[\begin{array}{l} CH_3 \\ | \\ CH - CH_2 \end{array} \right]_n$$

It is used in making gramophone records and ropes and in packing of textile materials.
(iii) Polystyrene : When styrene is polymerized in presence of benzoyl peroxide, polystyrene is formed.



It is used in making combs, ceiling tiles, TV cabinets, toys etc.

23. Vitamins are the biomolecules (other than the proteins, carbohydrates, lipids etc.) which are required in small amount to maintain normal health and growth as well as metabolic processes of human beings and animal organisms.
Vitamins are classified into following two classes :
(a) **Water soluble vitamins :** Vitamin B-complex *i.e.*, B_1, B_2, B_5, B_6 and B_{12}, and vitamin C are water soluble vitamins.
Water soluble vitamins must be supplied regularly in diet because they are regularly excreted in urine and cannot be stored (except vitamin B_{12}) in our body.
(b) **Water insoluble vitamins :** Vitamins A, D, E and K are water insoluble vitamins.
These are soluble in fat. They are stored in liver and adipose tissues.

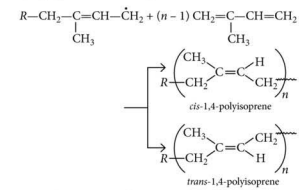
24. (i) Vitamin C is soluble in water and regularly excreted in urine and hence cannot be stored in body.
(ii) Vitamin A : Night blindness and xerophthalmia
Vitamin E : Muscular weakness and sterility
(iii) DNA is reserve of genetic information and responsible for heredity transmission.

25. (i) Isoprene is $CH_2 = \underset{\underset{CH_3}{|}}{C} - CH = CH_2$. If $\dot{R}$ is the free radical initiator, the free radical addition polymerization of isoprene can be described as follows :

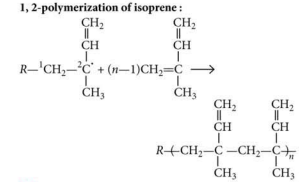
$$\dot{R} + \overset{\curvearrowright}{CH_2} = \underset{\underset{CH_3}{|}}{C} - CH = CH_2 \longrightarrow R - {}^1CH_2 - {}^2\overset{\curvearrowright}{C}H - {}^3CH = {}^4CH_2$$
$$\underset{\underset{CH_3}{|}}{}$$

$$\longleftrightarrow R - {}^1CH_2 - {}^2\underset{\underset{CH_3}{|}}{C} = {}^3CH - {}^4\dot{C}H_2$$

1, 4-polymerization of isoprene :



1, 2-polymerization of isoprene :



(ii)

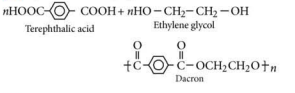
Characteristics	Polyester	Polyacrylate
Monomers	Both the monomers are bifunctional – One monomer molecule contains two –OH groups, whereas the other monomer contains two –COOH groups.	Only one monomer– unsaturated ester.
Mode of polymerization	Condensation (step growth) polymerization	Addition (chain growth) polymerization

OR

(i) Presence of double bond makes rubber reactive. This helps in vulcanisation of rubber. Due to the presence of double bonds, rubber exists in *cis* conformation which results in poor packing of molecules.

(ii) Vulcanisation of rubber is done in order to harden the natural rubber and increase its strength.

(iii) By condensation polymerisation.



(iv) A polymer always consists of large number of repeating structural units but a macromolecule may or may not consist of repeating structural units *e.g.*, proteins and nucleic acids should be regarded as macromolecules but not polymer since their molecule do not contain repeating structural units whereas cellulose is a polymer because it contains β-*D*-glucose as repeating units.

(v) Addition polymerisation gives a polymer containing carbon atoms only in the main chain.

26. (i) Aspirin inhibits the formation of chemicals called prostaglandins by blocking an essential enzyme needed for their production. Among the many properties of prostaglandins one is their ability to promote blood cells to stick together to form clots. Thus, blocking the formation of prostaglandins, aspirin decreases the likelihood of blood clot forming in the blood vessels. As aspirin prevents the formation of these clots, the heart attacks and strokes are less likely.

(ii) Hair consists of about 97% of a protein called keratin. The surface of keratin contains negatively charged amino acids. Hair conditioners, therefore, usually contain cationic detergents which do not wash out completely because their hydrophilic ends strongly bond to keratin, making the hair feel heavy. This is how they provide conditioning. Commonly used, cationic detergents in hair conditioners are cetrimonium chloride (hexadecyltrimethylammonium chloride). It is used at level between 1% and 5%. Distearyldimonium chloride is also used in hair conditioners.

(iii) Magnesium chloride or Mg^{2+} ions cause hardness in water. Therefore, ordinary soap, *e.g.*, $C_{17}H_{35}COONa$ forms a scum. As synthetic detergents do not cause any scum formation, they are suitable for washing clothes.

OR

(i) (a) **Broad spectrum antibiotics :** Effective against several different types of harmful microorganism. Example : chloramphenicol and tetracycline.

(b) **Narrow spectrum antibiotics :** Effective against a particular or limited number of harmful microorganism. Example : Penicillin.

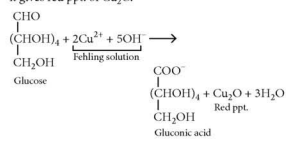
(ii) The drugs which are used to fight infectious diseases are known as antimicrobials. These are classified into following four groups:

I. Antibacterials II. Antivirals
III. Antifungals IV. Antiprotozoals

Sources of Antimicrobials:

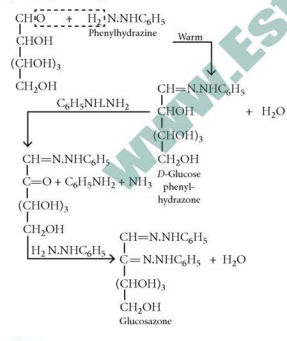
(a) Plants: Some of the plants are the good source to produce such drugs. Many antiinfective agents like quinine, emetine and berberine are derived from the plants.
(b) Moulds and Fungi
(c) Bacteria
(d) Semisynthetic or synthetic chemicals.

27. (i) When glucose is treated with Fehling solution, it gives red ppt. of Cu_2O.



Sucrose does not reduce Fehling solution.

(ii) When glucose is treated with excess of phenylhydrazine, glucosazone is formed.



OR

(i) The following reactions of *D*-glucose cannot be explained on the basis of its open chain structure :

(a) *D*-Glucose does not react with sodium bisulphite ($NaHSO_3$).
(b) It does not give 2, 4-DNP test and Schiff's test.
(c) The pentaacetate of *D*-glucose does not react with hydroxylamine.
(d) *D*-Glucose shows the phenomenon of mutarotation, *i.e.*, when its aqueous solution is kept for sometime its optical activity changes.
(e) On reaction with 1 mole of methanol, it yields two monomethyl derivatives which are known as methyl α-*D*-glucoside and methyl-β-*D*-glucoside.

(ii) (a) Hydrogen bonding

(b) Characteristic differences between globular and fibrous proteins can be given as :

S. No.	Globular proteins	Fibrous proteins
1.	These are cross-linked proteins and are condensation product of acidic and basic amino acids.	These are linear condensation polymer.
2.	These are soluble in water, mineral acids and bases.	These are insoluble in water but soluble in strong acids and bases.
3.	These proteins have three dimensional folded structure. These are stabilised by internal hydrogen bonding. *e.g.*, egg albumin, enzymes.	These are linear polymers held together by intermolecular hydrogen bonds. *e.g.*, hair, silk.

Class XII

MONTHLY TUNE UP!

PRACTICE PROBLEMS

These practice problems enable you to self analyse your extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Performance analysis table given at the end will help you to check your readiness.

- Haloalkanes and Haloarenes
- Alcohols, Phenols and Ethers

Total Marks : 120 **Time Taken : 60 Min.**

NEET / AIIMS

Only One Option Correct Type

1. Arrange the following compounds in the decreasing order of their reactivity towards S_N2 reaction :

(i) 

(ii) 

(iii) $CH_2=CH-CH_2Cl$

(iv) $CH_3CH_2CH_2Cl$

(a) iv > iii > i > ii (b) ii > i > iii > iv

(c) i > ii > iv > iii (d) iii > ii > i > iv

2. When an aromatic compound of molecular formula, $C_6H_4Br_2$ was nitrated then three isomers of formula, $C_6H_3Br_2NO_2$ were obtained. The original compound is

(a) *o*-dibromobenzene (b) *m*-dibromobenzene

(c) *p*-dibromobenzene (d) both (a) and (c).

3. Which of the following compounds on reaction with CH_3MgBr will give a tertiary alcohol?

(a) C_6H_5CHO (b) $C_2H_5COOCH_3$

(c) C_2H_5COOH (d) $CH_3CH-CHCH_3$ (O)

4. An alcohol of molecular formula, $C_5H_{11}OH$ on dehydration gives an alkene, which on oxidation yields a mixture of ketone and an acid. The alcohol is

(a) $CH_3CH_2CH(OH)CH_2CH_3$

(b) $CH_3CHCH_2CH_2CH_3$ (OH)

(c) $(CH_3)_2CHCH(OH)CH_3$

(d) all of these.

5. Identify the correct reactivity order for E2 reaction with alcoholic KOH.

(i) 

(ii) 

(iii) 

(a) i > ii > iii (b) ii > iii > i

(c) i > iii > ii (d) iii > i > ii

6. In the reaction,

$$\text{Phenol} \xrightarrow[\text{(ii) } CO_2/140\,^\circ C]{\text{(i) NaOH}} A \xrightarrow{H^+/H_2O} B \xrightarrow[CH_3COOH]{Al_2O_3} C$$

the end product *C* is

(a) salicylaldehyde (b) salicylic acid

(c) phenyl acetate (d) aspirin.

7. Identify *A* and *B* in the following reaction :

$$A \xleftarrow{C_2H_5OH} \underset{\text{(Major)}}{(CH_3)_3CBr} \xrightarrow[C_2H_5OH]{C_2H_5ONa} \underset{\text{(Major)}}{B}$$

(a) *A* is $(CH_3)_2C=CH_2$ and *B* is $(CH_3)_3COC_2H_5$.

(b) *A* is $(CH_3)_3COC_2H_5$ and *B* is $(CH_3)_2C=CH_2$.

(c) Both *A* and *B* are $(CH_3)_2C=CH_2$.

(d) Both *A* and *B* are $(CH_3)_3COC_2H_5$.

8. $CH_3-\underset{CH_3}{CH}-\underset{CH_3}{C}(Br)CH_3$ — MeO^-K^+ → X (Major); Et_3COK^+ → Y (Major)

X and Y are respectively

(a) $(CH_3)_2C=C(CH_3)_2$ and $(CH_3)_2CH-C\equiv C-H$

(b) $(CH_3)_2CH-C(H)=C(H)-CH_3$ and $CH_3-C(CH_3)=C(CH_3)-CH_3$

(c) $(CH_3)_2C=C(CH_3)_2$ and $(C_2H_5)_2C=C(CH_3)_2$

(d) $H_2C=C(CH_3)_2$ and $CH_3-C(CH_3)=C(CH_3)_2$

9. Correct order of the reactivity of the given alcohols towards the substitution reaction with ($NaBr + H_2SO_4$) is

(i)  CH_2OH

(ii) CH_3  CH_2OH

(iii) O_2N  CH_2OH

(iv) Me_2N  CH_2OH

(a) i > ii > iii > iv (b) iv > ii > i > iii

(c) iii > i > ii > iv (d) iv > iii > ii > i

10. The most volatile compound is

(a)  (b) 

(c)  (d) 

11. Wurtz reaction of methyl iodide yields an organic compound X. Which one of the following reactions also yields X?

(a) $C_2H_5Cl + Mg \xrightarrow{\text{dry ether}}$

(b) $C_2H_5Cl + LiAlH_4 \longrightarrow$

(c) $C_2H_5Cl + C_2H_5ONa \longrightarrow$

(d) $CHCl_3 \xrightarrow[\Delta]{\text{Ag powder}}$

12. In the following reaction,

$C_2H_5MgBr + H_2C\underset{O}{\diagdown\diagup}CH_2 \xrightarrow{H_2O} A$

'A' is

(a) $C_2H_5CH_2CHO$ (b) $C_2H_5CH_2OH$

(c) $C_2H_5CH_2CH_2OH$ (d) C_2H_5CHO

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

13. **Assertion :** Phenols react with active metals like sodium to form sodium phenoxide and H_2.
Reason : Phenols are weaker acids than alcohols.

14. **Assertion :** Alkyl iodide can be prepared by treating alkyl chloride/bromide with NaI in acetone.
Reason : NaCl/NaBr are soluble in acetone while NaI is not.

15. **Assertion :** In CH_3CH_2OH, the hydroxy group is not substituted on treatment with NaI/acetone but the same is substituted, if NaI is used with H_2SO_4.
Reason : —OH is a poor leaving group in NaI/acetone while a good leaving group in NaI/H_2SO_4.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. When HI is added in excess to the unsymmetrical ether

it results in

(a) $PhCH_2OH$ (b) PhI

(c) $HOCH_2CH_2PhNO_2$ (d) $ICH_2CH_2PhNO_2$

17. Identify the major product in the given reaction,

 $\xrightarrow{HI}$ Product

(a)  (b) 

(c)  (d) 

18. $(CH_3)_3CCl \xrightarrow[\Delta]{\text{alc. KOH}} X \xrightarrow{CF_3CO_3H} Y$

The product 'Y' is

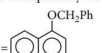
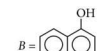
(a) $CH_2=CH-CH_2OH$

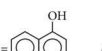
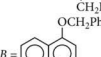
(b) 

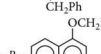
(c) $CH_3COCH_2CH_3$ (d) $(CH_3)_2CHCH_2OH$

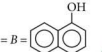
19. $A \xleftarrow[CF_3CH_2OH]{PhCH_2I}$  $\xrightarrow[DMSO]{PhCH_2I} B$

'A' and 'B' respectively are

(a) $A =$  $B =$ 

(b) $A =$  $B =$ 

(c) $A = B =$ 

(d) $A = B =$ 

More than One Options Correct Type

20. The possible structure of the alcohol is

$ROH(\text{alcohol}) \xrightarrow[\text{Heat}]{H_2SO_4}$ 

(a)  (b) 

(c)  (d) 

21. A new carbon-carbon bond formation is possible in which of the following reactions?

(a) $C_6H_6 + CH_3Cl \xrightarrow{AlCl_3}$

(b) $CH_3CH_2Br + CH_3CH_2NH_2 \longrightarrow$

(c) $CH_3CH_2Br + NaOCH_3 \longrightarrow$

(d) $CH_3CH_2Br + KCN_{(alc.)} \longrightarrow$

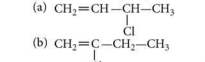
22. Which of the following halides gives white ppt. on treatment with $AgNO_3$ in the cold?

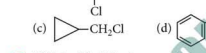
(a) $CH_2=CH-\underset{Cl}{CH}-CH_3$

(b) $CH_2=\underset{Cl}{C}-CH_2-CH_3$

(c)  (d) 

23. Which of the following constitutes a rearrangement?

(a) 

(b) 

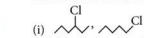
(c) 

(d) 

Numerical Value Type

24. Calculate total number of alpha hydrogens present in alkene formed when 2,3-dimethyl butanol react with concentrated H_2SO_4/Δ.

25. In how many pairs, the second compound reacts faster than the first in S_N1 reaction with OH^-?

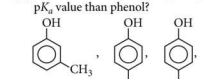
(i)  (ii) CH_3I, CH_3Br

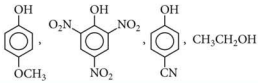
(iii) $(CH_3)_3CBr$, $(CH_3)_2CHBr$

(iv) CH_3Cl, $(CH_3)_2CHCl$

(v) $(CH_3)_2CHBr$, CH_3CH_2Br

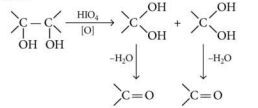
26. How many of the following compounds have lower pK_a value than phenol?





Comprehension Type

Vicinal diol on periodic acid oxidation gives a mixture of two carbonyl compounds which may be same or different.

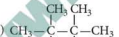


If diol is not vicinal then it is not oxidised by HIO_4. Cyclic diol on oxidation gives dicarbonyl compounds. By knowing the structures of carbonyl compounds formed we can get the structures of diols also.

27. 2 moles of cyclopentanone is obtained on HIO_4 oxidation of

(a) 
(b) 
(c) 
(d) 

28. Which one of the following will be oxidised by periodic acid?

(a) 
(b) 
(c) 
(d) 

Matrix Match Type

29. Match the column I with column II and choose the correct answer using the codes given below :

Column I	Column II
(A) 	(p) White turbidity with $HCl/ZnCl_2$
(B) CH_3CH_2OH	(q) Violet colour with $FeCl_3$
(C) $CH_3-\underset{\underset{Ph}{|}}{CH}-OH$	(r) Colour change with $Na_2Cr_2O_7, H^+$
(D) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-OH$	(s) I_2/OH^-, gives bright yellow ppt.

Codes :

	A	B	C	D
(a)	p, q	r, s	p, s	q
(b)	p, q, r	p	r, s	p, q, r
(c)	q	r, s	p, r, s	p
(d)	q	p, r, s	r, s	q

30. Match the chemical conversions in column I with the appropriate reagents in column II and choose the correct answer using the codes given below :

Column I	Column II
(A) 	(p) (i) $Hg(OAc)_2$ (ii) $NaBH_4$
(B)	(q) NaOEt
(C) 	(r) EtBr
(D) 	(s) (i) BH_3 (ii) $H_2O_2/NaOH$

Codes :

	A	B	C	D
(a)	q	r	p	s
(b)	p	q	r	s
(c)	q	r	s	p
(d)	p	q	s	r

Keys are published in this issue. Search now! ☺

CHECK YOUR PERFORMANCE

		If your score is	
No. of questions attempted	.....	> 80%	Your preparation is going good, keep it up to get high score.
No. of questions correct	.....	60-80%	Need more practice, try hard to score more next time.
Marks scored in percentage	.....	<60%	Stress more on concepts and revise thoroughly.

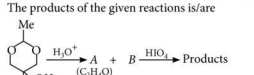
CHEMISTRY MUSING

PROBLEM SET 65

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / JIPMER with additional study material. In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.
The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

JEE MAIN/NEET

1. The products of the given reactions is/are

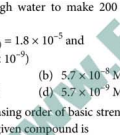


(a) CH_3CH_2COOH (b) HCHO
(c) HCOOH (d) both (a) and (b).

2. Regarding the complex $[Pt(Gly)_2Cl_2]$, which of the following statements is false?
(a) For this complex, a total six isomers are possible.
(b) It can exhibit geometrical isomerism.
(c) It can have optical isomers.
(d) It can exhibit linkage isomerism.

3. Calculate the value of $[OH^-]$ in a solution made by dissolving 0.005 moles each of ammonia and pyridine in enough water to make 200 cm^3 of a solution.
(Given: $K_{b(NH_4OH)} = 1.8 \times 10^{-5}$ and $K_{b(C_5H_5N)} = 1.52 \times 10^{-9}$)
(a) 6.7×10^{-4} M (b) 5.7×10^{-8} M
(c) 3.32×10^{-9} M (d) 5.7×10^{-9} M

4. The correct increasing order of basic strength of the labelled N in the given compound is



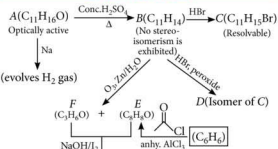
(a) I < II < III < IV (b) I < II < IV < III
(c) I < III < IV < II (d) IV < III < II < I

5. Identify the incorrect statement for the following reactions :
I. $SnCl_2 + H_2O \longrightarrow X + HCl$
II. $SnCl_2 + NaOH \longrightarrow Y + NaCl$
$\xrightarrow{NaOH\ (excess)}$ $Z + H_2O$
III. $SnCl_2 + AuCl_3 \longrightarrow SnCl_4 + P$
IV. $SnCl_2 + HCl + I_2 \longrightarrow SnCl_4 + Q$
(a) *X* shows white turbidity and is basic.
(b) *Y* is white precipitate and *Z* is soluble in.
(c) *P* is a non-metal. (d) *Q* is an acid.

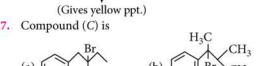
JEE ADVANCED

6. An organic compound, $C_aH_{2b}O_b$ was burnt with twice the amount of oxygen needed for complete combustion to CO_2 and H_2O. The hot gases when cooled to 0°C and 1 atm pressure, measured 2.24 L. The water collected during cooling weighed 0.9 g. The vapour pressure of pure water at 20°C is 17.5 mm of Hg and is lowered by 0.104 mm when 50 g of organic compound is dissolved in 1 kg of water. The molecular formula of the organic compound is
(a) $C_5H_{10}O_2$ (b) $C_5H_{10}O_5$
(c) $C_5H_{10}O_6$ (d) $C_6H_{12}O_6$

COMPREHENSION



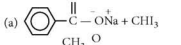
7. Compound (*C*) is

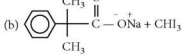


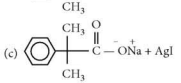
(c)  (d) 

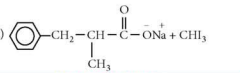
8. Compound $(A) \xrightarrow[\text{Acetone}_{(aq.)}]{H_2CrO_4} (R) \xrightarrow{NaOI} (S) + (T)$ (Yellow ppt.)

Compounds (S) and (T) respectively are

(a) 

(b) 

(c) 

(d) 

INTEGER VALUE

9. A mixture of Fe_2O_3 and Al is used in solid fuel rocket. The fuel value per mL of mixture will be (Given: $\Delta H_{Al_2O_3} = -399.0$ kcal; $\Delta H_{Fe_2O_3} = -199.0$ kcal; densities of Fe_2O_3 and Al are 5.2 g/mL and 2.7 g/mL respectively.)

10. Electrolysis of aqueous sodium chloride (X) forms three products A, B and C of which B and C are gases. B cannot react with A but C can react with A in cold condition to give X and Y and in hot condition to give X and Z. The difference in the oxidation states of element of C in Y and Z is

Scientist of the Month

Gerhard Heinrich
(25 December, 1904 - 3 March, 1999)

Early Life and Education

Herzberg was born in Hamburg, Germany. Herzberg started Vorschule (pre-school) late, after contracting measles. Gerhard and his family were atheists and kept this fact hidden. Herzberg graduated Vorschule shortly after his father's death. After completing high school at the Gelehrtenschule des Johanneums, Herzberg continued his education at Darmstadt University of Technology with the help of a private scholarship. Herzberg completed his Dr.-Ing. degree under Hans Rau in 1928. He did Post-doctoral work (1928-30) at the University of Göttingen and Bristol University under James Franck, Max Born, John Lennard-Jones.

Contributions

- 1936-45 Professor of Physics, University of Saskatchewan
- 1939 Fellow of the Royal Society of Canada
- 1945-48 Professor of spectroscopy, Yerkes Observatory, University of Chicago (Chicago, United States)
- 1948 Director of the Division of Pure Physics, National Research Council of Canada
- 1951 Fellow of the Royal Society of London
- 1957-63 Vice President of the International Union of Pure and Applied Physics
- 1956-57 President of the Canadian Association of Physicists
- 1960 gives Bakerian Lecturer of the Royal Society of London
- 1966-67 President of the Royal Society of Canada
- 1968 Companion of the Order of Canada
- 1968 George Fischer Baker Non-Resident Lecturer in Chemistry at Cornell University (Ithaca, United States)
- 1969 Distinguished Research Scientist in the recombined Division of Physics, at the National Research Council of Canada
- 1973-1980 Chancellor of Carleton University (Ottawa, Ontario, Canada)
- 1981 Founding member of the World Cultural Council.
- 1992 Sworn into the Queen's Privy Council for Canada
- Herzberg authored some classic works in the field of spectroscopy, including Atomic Spectra and Atomic Structure and the encyclopaedic four volume work: Molecular Spectra and Molecular Structure, which is often called the spectroscopist's bible.

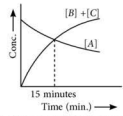
Honors

- Herzberg's most significant award was the 1971 Nobel Prize in Chemistry, which he was awarded "for his contributions to the knowledge of electronic structure and geometry of molecules, particularly free radicals". During the presentation speech, it was noted that at the time of the award, Herzberg was "generally considered to be the world's foremost molecular spectroscopist."
- Herzberg was honoured with memberships or fellowships by a very large number of scientific societies, received many awards and honorary degrees in different countries.
- The NSERC Gerhard Herzberg Canada Gold Medal for Science and Engineering, Canada's highest research award, was named in his honour in 2000.
- The Herzberg Institute of Astrophysics is named for him.
- In 1964 he was awarded the Frederic Ives Medal by the OSA.
- Faraday medal in 1970.
- 1971 Royal Medal from Royal Society of London

GEAR UP FOR JEE MAIN 2019

Exam Dates : Between 6th to 20th January and between 6th to 20th April 2019

1. A first order reaction, $2A_{(g)} \longrightarrow B_{(g)} + C_{(g)}$ follows the path shown in the diagram :



After 50 minutes what will be the percentage of *A* left?

(a) 10 (b) 20 (c) 30 (d) 50

2. A student was given 2 mL of solutions *A* and *B* separately. She added aqueous solution of $NaHCO_3$ in both the solutions and then she treated both solutions with neutral ferric chloride solution. Observations are recorded in the given table.

Solutions	$NaHCO_3$ test	$FeCl_3$ test
A	No reaction	Violet colouration
B	Brisk effervescence	Red colouration

Solutions *A* and *B* are respectively

(a) acetic acid and phenol
(b) phenol and oxalic acid
(c) formic acid and phenol
(d) phenol and acetic acid.

3. An ester (I) with molecular formula $C_5H_{10}O_2$ was treated with excess of CH_3MgBr and the complex so formed was treated with H_2SO_4 to give an olefin (II). Ozonolysis of (II) gave a ketone with molecular formula C_5H_8O and formaldehyde which shows positive iodoform test. The structure of (I) is

(a) $C_6H_5COOC_2H_5$ (b) $C_6H_5COOC_6H_5$
(c) $H_3COCH_2COC_6H_5$
(d) p-CH_3O—C_6H_4—$COCH_3$

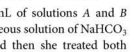
4. A gaseous system is initially characterised by 500 mL volume and 1 atm pressure at 298 K. This system is allowed to do work

(i) in isobaric conditions it expands to 800 mL resulting a decrease in pressure and temperature to 0.6 atm and 273 K respectively.
(ii) in adiabatic conditions it is allowed to expand upto 800 mL and results a decrease in pressure and temperature to 0.6 atm and 273 K respectively.

If Gibbs energy change in (i) is ΔG_a and in (ii) is ΔG_b, then what will be the ratio of $\frac{\Delta G_a}{\Delta G_b}$?

(a) 0 (b) 1
(c) between 0-1 (d) > 1

5. Which of the following reactions does not take place?

(a) 

(b) $(CH_3)_3CCl$ + aq. KOH $\longrightarrow$

(c) $(CH_3)_3CCl$ + alc. KOH $\longrightarrow$

(d) 

6. Following statements regarding the periodic trends of chemical reactivity of alkali metals and the halogens are given. Which of the following statements is correct?

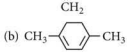
(a) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens.
(b) In alkali metals the reactivity increases but in the halogens it decreases with increase in atomic number down the group.
(c) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number.
(d) In both the alkali metals and the halogens, the chemical reactivity decreases with increase in atomic number down the group.

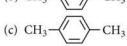
7. The equilibrium concentration of the reactants and products for the given equilibrium in a two litre container are shown below.

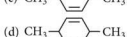
$$\underset{2\ M}{PCl_{3(g)}} + \underset{1\ M}{Cl_{2(g)}} \rightleftharpoons \underset{4\ M}{PCl_{5(g)}}$$

If 2 moles of Cl_2 are added in the container, then the new equilibrium concentration of $PCl_{5(g)}$ will be
(a) 1 M (b) 1.5 M (c) 4 M (d) 4.5 M

8. An organic compound $A(C_6H_{12})$ on reaction with ozone followed by Zn gave one mole each of $(CHO)_2$ and $CH_3COCH_2CH_2COCH_3$. The structure of A is
(a) $CH_3-\underset{\underset{CH_2}{\|}}{C}-CH_2CH_2-\underset{\underset{CH_2}{\|}}{C}-CH_3$

(b) 

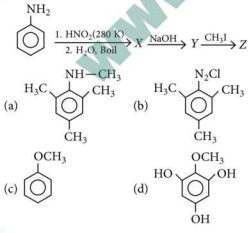
(c) 

(d) 

9. Equimolal solutions of A and B show depression in freezing point in the ratio 2 : 1. A remains in its normal state in solution. B will be _____ in solution.
(a) normal (b) dissociated
(b) associated (d) hydrolysed

10. Two liquids A and B are made up of same atoms. Both A and B are diamagnetic. A turns blue litmus to red and also gives blue colour with acidified KI and starch solution when added to it but B does not give both of these reactions. A and B are respectively
(a) H_2O, H_2O_2 (b) H_2O_2, H_2O
(c) H_2SO_3, H_2SO_4 (d) H_2SO_4, H_2SO_3

11. Identify 'Z' in the reaction given below :



12. One mole each of H_3PO_2, H_3PO_3 and H_3PO_4 will neutralise x mol of NaOH, y mol of $Ca(OH)_2$ and z mol of $Al(OH)_3$ (assuming all as strong electrolytes) respectively. x, y and z are in the ratio of
(a) 3 : 1.5 : 1 (b) 1 : 2 : 3
(c) 3 : 2 : 1 (d) 1 : 1 : 1

13. The volume of 0.05 M $KMnO_4$ solution required to oxidize completely 2.70 g of oxalic acid $(H_2C_2O_4)$ in acidic medium will be
(a) 120 cm^3 (b) 240 cm^3
(c) 360 cm^3 (d) 480 cm^3

14. Identify the correct statement regarding enzymes.
(a) Enzymes are specific biological catalysts that can normally function at very high temperature ($T \sim 1000$ K).
(b) Enzymes are normally heterogeneous catalysts that are very specific in action.
(c) Enzymes are specific biological catalysts that cannot be poisoned.
(d) Enzymes are specific biological catalysts that possess well-defined active sites.

15. A compound X on heating gives a colourless gas and a residue. The residue is dissolved in water to obtain Y. When excess CO_2 is passed through aqueous solution of Y then Z is formed, Z on gentle heating gives back X. The compound X is
(a) $NaHCO_3$ (b) Na_2CO_3
(c) $Ca(HCO_3)_2$ (d) $CaCO_3$

16. Arrange the following alcohols in the increasing order of reactivity with HBr.
I. benzyl alcohol
II. *p*-methyl benzyl alcohol
III. *p*-nitrobenzyl alcohol
IV. *p*-chlorobenzyl alcohol
(a) I < II < III < IV (b) III < IV < I < II
(c) II < I < IV < III (d) IV < III < II < I

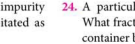
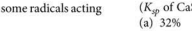
17. Two labels sticked upon the two bottles containing conc. H_2SO_4 are shown below

A	*B*
Conc. H_2SO_4 (90% by volume) Density = 1.98 g/mL	Conc. H_2SO_4 (93% by volume) Density = 1.84 g/mL

Molalities of acids A and B are respectively
(a) 8.5, 10.4 (b) 10.4, 8.5
(c) 4.2, 5.2 (d) 5.2, 4.2

18. Sometimes yellow turbidity appears while passing H_2S gas even in the absence of second group radicals. This is because

(a) sulphur is present in the mixture as an impurity
(b) the fourth group radicals get precipitated as sulphides
(c) the oxidation of H_2S gas by some radicals acting as oxidant
(d) the third group radicals get precipitated as hydroxides.

19. Which of the following sets form the biodegradable polymer?
(a) $H_2C{=}CH{-}CN$ and $H_2C{=}CH{-}CH{=}CH_2$
(b) $HOCH_2{-}CH_2OH$ and 
(c) $H_2N{-}CH_2{-}COOH$ and $H_2N{-}(CH_2)_5{-}COOH$
(d) $H_2C{=}CH{-}CH{=}CH_2$ and 

20. Which of the following mixture will lead to the formation of negatively charged colloid $[AgI]I^-$?
(a) 50 mL of 0.1 M $AgNO_3$ + 50 mL of 0.1 M KI
(b) 50 mL of 0.1 M $AgNO_3$ + 50 mL of 0.2 M KI
(c) 50 mL of 0.2 M $AgNO_3$ + 50 mL of 0.2 M KI
(d) 50 mL of 0.2 M $AgNO_3$ + 50 mL of 0.1 M KI

21. The angular momentum of an electron in a Bohr's orbit of H atom is 4.2178×10^{-34} kg m^2/sec. The wavelength of spectral line emitted when electron falls from this level to next lower level, is
(a) 1.0×10^{-4} cm (b) 1.9×10^{-4} cm
(c) 3.6×10^{-4} cm (d) 5.4×10^{-4} cm

22. In a mixed aldol condensation with ethanal as one aldehyde, which other from the following is expected to give maximum yield of cross condensation product?
(a)  (b) 
(c) $CH_3{-}\overset{\overset{O}{\|}}{C}{-}CH_3$ (d) 

23. Identify X and Y in the given reactions.
$KI + MnO_4^- \xrightarrow{H^+} X + Mn^{2+}$
$KI + MnO_4^- \xrightarrow{OH^-} IO_3^- + Y$
(a) IO_3^-, MnO_2 respectively
(b) I_2, Mn^{2+} respectively
(c) IO_3^-, Mn^{2+} respectively
(d) I_2, MnO_2 respectively

24. A particular water sample has 131 ppm $CaSO_4$. What fraction of the water must be evaporated in a container before solid $CaSO_4$ begins to deposit? (K_{sp} of $CaSO_4 = 9.0 \times 10^{-6}$)
(a) 32% (b) 68% (c) 50% (d) 24%

25. An evacuated vessel weighs 50 g when empty, 144 g when filled with a liquid of density 0.47 g mL^{-1} and 50.5 g when filled with an ideal gas at 760 mmHg and 300 K. The molar mass of the ideal gas is
(Given : $R = 0.0821$ L atm K^{-1} mol^{-1})
(a) 61.575 (b) 130.98
(c) 123.75 (d) 47.87

26. Pick up the correct statement.
(a) SO_2, which is a major pollutant resulting from the combustion of fuels in automobiles plays a major role in photochemical smog.
(b) Classical smog has an oxidizing character while the photochemical smog is reducing in character.
(c) Photochemical smog occurs in day time whereas the classical smog occurs in early morning hours.
(d) During formation of smog the level of ozone in the atmosphere goes down.

27. In the following sets of compounds, the one which contains only medicinal compounds is
(a) alizarin, phenacetin, morphine
(b) 9-oxodecanoic acid, boric acid, morphine
(c) boric acid, chloramphenicol, aspirin
(d) aspirin, gentian violet, phenolphthalein.

28. In which of the following ionization processes, the bond order has increased as well as the magnetic behaviour has changed?
(a) $N_2 \rightarrow N_2^+$ (b) $C_2 \rightarrow C_2^+$
(c) $NO \rightarrow NO^+$ (d) $O_2 \rightarrow O_2^+$

29. Arrange the following in order of decreasing heat of combustion?
I.  II. 
III.  IV. 
(a) I > III > II > IV (b) I > II > IV > III
(c) III > IV > II > I (d) II > IV > I > III

30. Choose the incorrect statement.
(a) For the complex, $[Co(NH_3)_6]^{3+}$, NH_3 is a strong field ligand, so that $\Delta_o > P$ and thus it is a low spin complex.

(b) For the complex, $[CoF_6]^{3-}$, F^- is a weak field ligand so that $\Delta_o < P$ (electron pairing energy) and it is thus a high spin complex.

(c) $\Delta_t = -\frac{4}{9}\Delta_o$

(d) Greater the ionic charge on the central metal ion, the greater the value of CFSE.

SOLUTIONS

1. (a) : From the reaction, $2A \longrightarrow B + C$, it is clear that when the total concentration of B and C is same with concentration of A, the corresponding time is $t_{1/2}$ of dissociation of A.

$$\therefore\ k = \frac{0.693}{t_{1/2}} = \frac{0.693}{15}\,\text{min}^{-1} = 0.0462\,\text{min}^{-1}$$

	$2A$	$\longrightarrow$	B	+	C
$t = 0$	a		0		0
$t = 50$ min	$a - x$		$x/2$		$x/2$

$$\therefore\ 0.0462 = \frac{2.303}{50}\log\frac{a}{a-x}$$

$$\text{or}\ \log\frac{a}{a-x} = 1 \text{ or } \frac{a}{a-x} = 10$$

$$\therefore\ \frac{a-x}{a} = \frac{1}{10}$$ *i.e.*, 10% of A is left after 50 minutes.

2. (d) : Phenol does not respond to $NaHCO_3$ test and gives violet colour with $FeCl_3$. Acetic acid gives brisk effervescence with $NaHCO_3$ and red colour on treating with $FeCl_3$.

3. (a) : $C_6H_5COC_2H_5 + CH_3MgBr$

(I)

$\xrightarrow[H_3O^+]{CH_3MgBr}$ $C_6H_5-\underset{\underset{OMgBr}{|}}{\overset{\overset{CH_3}{|}}{C}}-OC_2H_5$

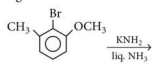
$\xrightarrow[H_2SO_4]{\text{Conc.}}$ $C_6H_5-\underset{OH}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH_3 \longrightarrow C_6H_5-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}=CH_2$

(II)

$\xrightarrow{O_3}$ $C_6H_5-C=O + HCHO$

4. (b) : $\frac{\Delta G_a}{\Delta G_b} = 1$ as Gibbs energy is a state function and initial and final states are same in (i) and (ii).

5. (a) : Aryl halides having at least one hydrogen in *ortho* position undergo nucleophilic substitution with a very strong base like KNH_2 or $NaNH_2$ in liquid ammonia. This reaction proceeds via benzyne (aryne) intermediate. Aryl halides having no hydrogen *ortho* to the halogen do not react under the same conditions.



No reaction

6. (b) : In alkali metals, the reactivity increases down the group due to decrease in IE_1. But in case of halogens, the reactivity decreases down the group due to decrease in their electrode potentials.

7. (d) : $PCl_{3(g)} + Cl_{2(g)} \rightleftharpoons PCl_{5(g)}$

2 M 1 M 4 M

$$\therefore\ K_c = \frac{[PCl_5]}{[PCl_3][Cl_2]} = \frac{4}{2\times1} = 2$$

Now 2 moles of Cl_2 are added to 2 L container and so $[Cl_2]$ is increased by 1 M, which favours the forward reaction. Thus,

	PCl_3	+	Cl_2	$\rightleftharpoons$	PCl_5
	2M		1M + 1M		4M
at eqm.	$(2-x)$		$(2-x)$		$(4+x)$

$$K_c = \frac{(4+x)}{(2-x)^2}$$

$$2 = \frac{(4+x)}{(2-x)^2} \Rightarrow x = 0.5$$

Thus, new concentrations of reactants and products at equilibrium are

$[PCl_3] = 1.5$ M ; $[Cl_2] = 1.5$ M ; $[PCl_5] = 4.5$ M

8. (b) : CH_3-  $-CH_3 \xrightarrow[(ii)\ Zn/CH_2O]{(i)\ O_3/CH_2Cl_2}$

$CH_3-\overset{O}{\overset{||}{C}}-CH_2CH_2-\overset{O}{\overset{||}{C}}-CH_3 + O=CH-CH=O$

9. (c) : $\frac{\Delta T_{f_A}}{\Delta T_{f_B}} = \frac{2}{1} = \frac{1}{1/2}$, *i.e.*, B should be associated in solution.

MONTHLY TUNE UP CLASS XII ANSWER KEY

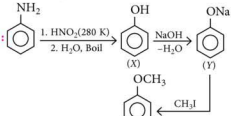
1.	(b)	**2.**	(b)	**3.**	(b)	**4.**	(c)	**5.**	(a)
6.	(d)	**7.**	(b)	**8.**	(a)	**9.**	(b)	**10.**	(a)
11.	(b)	**12.**	(c)	**13.**	(c)	**14.**	(c)	**15.**	(a)
16.	(d)	**17.**	(a)	**18.**	(b)	**19.**	(b)		
20.	(a,b)	**21.**	(a,d)	**22.**	(a,c,d)	**23.**	(b,c,d)		
24.	(12)	**25.**	(1)	**26.**	(4)	**27.**	(c)		
28.	(b)	**29.**	(c)	**30.**	(a)				

10. (b) : Liquid A is H_2O_2 and B is H_2O.
Both are made up of same atoms and both are diamagnetic. Aqueous solution of H_2O_2 is weakly acidic and turns blue litmus to red but H_2O does not.
Also, $2KI + \underset{A}{H_2O_2} + H_2SO_4 \longrightarrow K_2SO_4 + I_2 + 2H_2O$

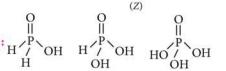
I_2 + Starch $\longrightarrow$ (Starch – I_2) complex
Blue

But H_2O does not give this reaction.

11. (c) :



12. (d) :



H_3PO_2 = monobasic ; H_3PO_3 = dibasic ; H_3PO_4 = tribasic (one ionisable H^+) (two ionisable H^+) (three ionisable H^+)

13. (b) : $2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$

5 moles of oxalic acid react with 2 moles of $KMnO_4$

2.70 g oxalic acid = $\frac{2.70}{90}$ mole

$\therefore$ $\frac{2.70}{90}$ mole of oxalic acid will react with

$$= \frac{2}{5} \times \frac{2.70}{90} = 0.012 \text{ mole } KMnO_4$$

0.05 mole of $KMnO_4$ is present in 1000 cm^3
$\therefore$ 0.012 mole of $KMnO_4$ will be present in

$$\frac{1000}{0.05} \times 0.012 \text{ cm}^3 = 240 \text{ cm}^3$$

14. (d) : Enzymes are shape selective biological catalysts which normally functions effectively at body temperature.

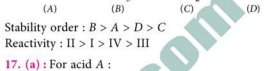
15. (d) : $\underset{(X)}{CaCO_3} \xrightarrow{\text{Heat}} \underset{\text{Residue}}{CaO} + \underset{\text{Colourless gas}}{CO_2\uparrow}$

$CaO + H_2O \longrightarrow \underset{(Y)}{Ca(OH)_2}$
Residue

$Ca(OH)_2 + 2CO_2 \longrightarrow \underset{(Z)}{Ca(HCO_3)_2}$
(Y) Excess

$\underset{(Z)}{Ca(HCO_3)_2} \xrightarrow{\text{Heat}} \underset{(X)}{CaCO_3} + CO_2 + H_2O$

16. (b) : In the reaction, reactive intermediate carbocation is involved, hence greater the stability of carbocation, greater the reactivity of corresponding alcohols.



Stability order : $B > A > D > C$
Reactivity : II > I > IV > III

17. (a) : For acid A :
W_{acid} = 90 g, $V_{solution}$ = 100 mL,
d = 1.98 g/mL, $W_{solution}$ = 1.98 × 100 = 198 g

$$\therefore \quad m = \frac{W_{acid}}{M_{acid}} \times \frac{1000}{W_{water}} = \frac{90}{98} \times \frac{1000}{(198-90)} = 8.50$$

For acid B :
W_{acid} = 93 g, $V_{solution}$ = 100 mL,
d = 1.84 g/mL, $W_{solution}$ = 1.84 × 100 = 184 g

$$m = \frac{W_{acid}}{M_{acid}} \times \frac{1000}{W_{water}} = \frac{93}{98} \times \frac{1000}{(184-93)} = 10.4$$

18. (c) : $H_2S + [O] \longrightarrow H_2O + S$ (yellow precipitate)

19. (c)

20. (b) : $[AgI]I^-$ colloid will be formed only when the iodide ion is present in excess.

21. (b) : According to Bohr's law, $mvr = \frac{nh}{2\pi}$

$\therefore$ $\frac{nh}{2\pi} = 4.2178 \times 10^{-34}$

or $n = \frac{4.2178 \times 10^{-34} \times 2 \times 3.14}{6.625 \times 10^{-34}} = 4$

$$\frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

The transition spectral line for 4th to 3rd shell is

$$\frac{1}{\lambda} = 109678 \times \left[\frac{1}{3^2} - \frac{1}{4^2}\right] \Rightarrow \lambda = 1.9 \times 10^{-4} \text{ cm}$$

22. (b) : Nucleophilic addition at carbonyl carbon of cyclopropane releases angle strain.

23. (d) : $MnO_4^- + I^- \xrightarrow{H^+} \underset{(X)}{I_2} + Mn^{2+} + H_2O$

$MnO_4^- + I^- \xrightarrow{OH^-} \underset{(Y)}{IO_3^-} + MnO_2$

24. (b) : Maximum solubility of $CaSO_4$ in water,

$s = \sqrt{K_{sp}} = 3 \times 10^{-3}$ mol L^{-1}

Let the volume of sample is V L, thus mass of $CaSO_4$ present $= \frac{131 \times V \times 10^3}{10^6}$ g

[$\because$ ppm = g of $CaSO_4$ in 10^6 g of sample]

$= 131 \times 10^{-3}\ V$ g

$= \frac{131 \times V \times 10^{-3}}{136}$ mole/ V L

Now water is evaporated by heating so that just deposition of $CaSO_4$ occurs. Let V_1 L of water is left, then $\frac{131 \times V \times 10^{-3}}{136}$ mole are present in V_1 L solution which are equal to $3 \times 10^{-3} \times V_1$ mole.

$\therefore \frac{131 \times V \times 10^{-3}}{136} = 3 \times 10^{-3} \times V_1$

$V_1 = 0.32\ V$

Thus, volume evaporated $= V - 0.32\ V = 0.68\ V$ or 68%

25. (a) : Mass of liquid filling the vessel = 144 – 50 = 94 g

Volume of liquid = Volume of vessel

$= \frac{94 \text{ g}}{0.47 \text{ g mL}^{-1}} = 200$ mL

$\therefore$ Volume of gas (V) = 200 mL = 0.2 L

Pressure (P) = 760 mm = 1 atm

Temperature (T) = 300 K

Mass of the gas = 50.5 – 50 = 0.5 g

$PV = nRT = \frac{w}{M}RT$

$\therefore M = \frac{wRT}{PV} = \frac{0.5 \times 0.0821 \times 300}{1 \times 0.2} = 61.575$

26. (c)

27. (c) : Boric acid (mild antiseptic), chloramphenicol (antibiotic) and aspirin (antipyretic as well as analgesic) are all medicinal compounds.

28. (c) : $N_2 : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \pi_{2p_x}^2 \pi_{2p_y}^2\ \sigma_{2p_z}^2$ (B.O = 3, Diamagnetic)

$N_2^+ : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \pi_{2p_x}^2 \pi_{2p_y}^2 \sigma_{2p_z}^1$ (B.O = 2.5, Paramagnetic)

$C_2 : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \pi_{2p_x}^2 \pi_{2p_y}^2$ (B.O = 2, Diamagnetic)

$C_2^+ : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \pi_{2p_x}^2 \pi_{2p_y}^1$ (B.O = 1.5, Paramagnetic)

$NO : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 \pi_{2p_y}^{*1}$ (B.O. = 2.5, Paramagnetic)

$NO^+ : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 \pi_{2p_y}^2$ (B.O. = 3, Diamagnetic)

$O_2 : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 \pi_{2p_y}^1 \pi_{2p_x}^{*} \pi_{2p_y}^{*1}$ (B.O = 2, Paramagnetic)

$O_2^+ : KK\ \sigma_{2s}^2 \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 \pi_{2p_y}^2 \pi_{2p_x}^{*1}$ (B.O = 2.5, Paramagnetic)

29. (c) : The stability decreases in the order : cyclohexane (I) > cyclopentane (II) > cyclobutane. Further, *trans*-1, 2-dimethylcyclobutane (IV) is more stable than *cis*-1, 2-dimethylcyclobutane (III). Thus, stability decreases in the order : I > II > IV > III. Therefore, their heat of combustion decreases in the reverse order: III > IV > II > I.

30. (c) : $\Delta_t = +\frac{4}{9}\Delta_o$

Solution Senders of Chemistry Musing

Set - 63

- Amar Pramanik, West Bengal

Set - 64

- Subhadip Panda, West Bengal
- Tulasi Ashok, Andhra Pradesh
- Shreesh Chakraborty, West Bengal

Solution Senders of Unscrambled Words

- Devjit Acharjee, West Bengal

CONCEPT BOOSTER

Hello students! Another festive season has just ended. Hope you all had a nice time spent. Now its time to gear up for the upcoming examinations. The most important part is how to prepare and how to keep things in mind. The first answer is study regularly and what you study just pen down that. Second answer is if possible keep everything in mind with shortcuts and mnemonics. I have just tried this in this issue. Let me check if you like it. Lots of suprising articles are coming in the upcoming months. Keep you eyes on Chemistry Today.

*Arunava Sarkar

EXPLORE PHYSICAL CHEMISTRY

Conductance

1. The mobility of Na^+ ion is 7.623×10^{-8} m^2 V^{-1} s^{-1}. Calculate :

(i) The ionic conductivity of Na^+ ion.

(ii) The velocity of the ion if 15.0 volt is applied across electrodes 25 cm apart.

(iii) The transport number of the ions in $NH_4C_2H_3O_2$ solution if the mobility of $C_2H_3O_2^-$ ion is 4.239×10^{-8} m^2 V^{-1} S^{-1}.

Sol.:(i) Ionic conductivity of Na^+ is

(96485 coulomb $equiv^{-1}$) $\times$ (7.623×10^{-8} m^2 V^{-1} S^{-1})

= (96485 $\times$ 7.623×10^{-8}) ohm^{-1} m^2 $equiv^{-1}$

= 73.55×10^{-4} ohm^{-1} m^2 $equiv^{-1}$

(ii) Potential gradient = $\frac{15}{0.25}$ volt m^{-1} = 60 V m^{-1}

Speed of the ion = ionic mobility $\times$ potential gradient

= ($7.623 \times 10^{-8} \times 60$) m s^{-1}

= 4.574×10^{-6} m s^{-1}

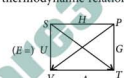
(iii) Transport number of Na^+

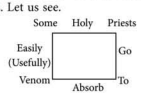
$$= \frac{u_{Na^+}}{u_{Na^+} + u_{C_2H_3O_2^-}} = \frac{7.623 \times 10^{-8}}{(7.623 + 4.239) \times 10^{-8}} = 0.643$$

A VERY USEFUL SHORTCUT TRICK

Maxwell Thermodynamic Square

Thermodynamic square (Born square) is actually a mnemonic diagram or representation given by Max Born. This helps enormously to determine thermodynamic relations. Let us see.



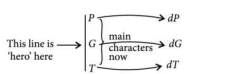


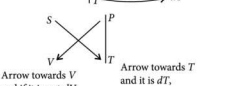
Now, Maxwell equation:

(Arrow pointed to "what" can't be positive if it is in the form of dx)

$$VdP - SdT = dG$$

How?





Thus, $VdP - SdT = dG$ ... (1)

Similarly, $dA = -PdV - SdT$ ... (2)

$dH = TdS + VdP$ ... (3)

$dU = TdS - PdV$ ... (4)

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

Now, let's see, Maxwell relation

$$\left(\frac{dS}{dV}\right)_T = \left(\frac{dP}{dT}\right)_V \quad \text{... (5)}$$

How?

Arrow towards T so, T constant

If arrow reverses, then –ve

$$\therefore \left(\frac{dS}{dV}\right)_T = \left(\frac{dP}{dT}\right)_V$$

For example,

$$\left(\frac{dS}{dP}\right)_T = \left(-\frac{dV}{dT}\right)_P \quad \text{... (6)}$$

$$\left(\frac{dV}{dS}\right)_P = \left(\frac{dT}{dP}\right)_S \quad \text{... (7)}$$

$$\left(\frac{dP}{dS}\right)_V = -\left(\frac{dT}{dV}\right)_S \quad \text{... (8)}$$

Now, take $dG = VdP - SdT$ ... [From (1)]

If P is constant, $dP = 0$

$\therefore$ At constant P, $dG = -SdT$

$$\Rightarrow S = \left(-\frac{dG}{dT}\right)_P$$

Now, at constant temperature, $dT = 0$.

$$\therefore \quad dG = VdP - S \cdot 0 \quad \Rightarrow \quad \left(\frac{\partial G}{\partial P}\right)_T = V$$

Similarly, $P = \left(-\frac{\partial U}{\partial V}\right)_S = -\left(\frac{\partial A}{\partial V}\right)_T$

or, $\left(\frac{\partial A}{\partial T}\right)_V = -S$

Some more relations are :

$$T = \left(\frac{\partial H}{\partial S}\right)_P ; \; V = \left(\frac{\partial H}{\partial P}\right)_S$$

[From the relation, $dH = TdS + VdP$]

and $\left(\frac{\partial U}{\partial S}\right)_V = T ; \; -\left(\frac{\partial U}{\partial V}\right)_S = -P$

[From the relation, $dU = TdS - PdV$]

ATTENTION!! CHANGING TRENDS IN JOB PROFILES BY 2022

World Economic Forum has come up with Future of Jobs Report 2018 that mentions the job profiles that might not be in demand by 2022 and the ones with maximum scope for growth. Due to technological advancements, many profiles that need manual support presently might get automated and hence may turn obsolete. In fact, the report suggests that the world would lose around whopping 75 million jobs by 2022.

According to the report, job roles such as data entry clerks, accounting, bookkeeping and payrolls checks, administrative and executive secretaries, assembly and factory workers, client information and customer service workers, business services and administration managers might get extinct in the coming time. Other profiles in the list were accountants and auditors, material-recording and stock-keeping clerks, general operations managers and postal service clerks.

The emerging professions include data analyst and scientists, AI and machine learning, general and operation managers, software and applications developers and analysts, sales and marketing professionals, big data specialist, digital transformation specialists, new technology specialist, organisational development specialists and information technology services.

The report also lists down the professions that would generate new job opportunities and the good news is that there would be 133 million jobs created by 2022 in the line.

Comparing Top Ten skills demands, 2018 verses 2022

Today, 2018	Trending 2022	Declining 2022
Analytical thinking and innovation	Analytical thinking and innovation	Manual dexterity, endurance and precision
Complex problem-solving	Active learning and learning strategies	Memory, verbal, auditory and spatial abilities
Critical thinking and analysis	Creativity, originality and initiative	Management of financial, material resources
Active learning and learning strategies	Technology design and programming	Technology installation and maintenance
Creativity, originality and initiative	Critical thinking and analysis	Reading, writing, math and active listening
Attention to detail, trustworthiness	Complex problem-solving	Management of personnel
Emotional intelligence	Leadership and social influence	Quality control and safety awareness
Reasoning, problem-solving and ideation	Emotional intelligence	Coordination and time management
Leadership and social influence	Reasoning, problem-solving and ideation	Visual, auditory and speech abilities
Coordination and time management	Systems analysis and evaluation	Technology use, monitoring and control

CHEMISTRY MUSING

SOLUTION SET 64

1. (b): $\underset{(X)}{SO_3^{2-}} + 2H^+ \longrightarrow \underset{(Y)}{SO_2} + H_2O$

$\underset{(Y)}{3SO_2} + K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

Green coloured solution

2. (a): $\frac{C_p}{C_v} = \frac{441}{315} = 1.4$

∴ Gas is diatomic (γ = 1.4 for diatomic gases).

∴ From $PV = nRT$

$$\Rightarrow n = \frac{PV}{RT} \Rightarrow \frac{w}{M} = \frac{PV}{RT}$$

$$\Rightarrow M = \frac{wRT}{PV}$$

Now for diatomic gas,

$$\text{Atomic mass} = \frac{M}{2} = \frac{wRT}{2PV} = \frac{7.0 \times 0.082 \times 300}{2 \times 1 \times 4.1} = 21\ \text{u}$$

3. (d): In S_N1 reaction, 3° and 2° alkyl halides react faster than 1° alkyl halides as 3° and 2°-carbocations are more stable than 1°-carbocations.

Br^- ion is a better leaving group than Cl^- ion.

Benzyl carbocation is more stable than 2°-carbocation hence, it reacts more rapidly than 2°-alkyl halide.

4. (b): $W = -p(V_2 - V_1) = -p\left(\frac{nRT}{p} - 0\right) = -nRT$

Initial volume = 0 (being solid)

Final volume = due to n moles of gas from 1 mole of reactant

$$\underset{1\ \text{mol}}{CaC_{2(s)}} + 2H_2O \longrightarrow Ca(OH)_2 + \underset{1\ \text{mol}}{C_2H_{2(g)}}$$

$$\underset{1\ \text{mol}}{Al_4C_{3(s)}} + 12H_2O \longrightarrow 4Al(OH)_3 + \underset{3\ \text{mol}}{3CH_{4(g)}}$$

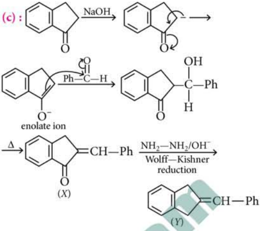
$$\underset{1\ \text{mol}}{Mg_2C_{3(s)}} + 4H_2O \longrightarrow 2Mg(OH)_2 + \underset{1\ \text{mol}}{CH_3-C\equiv CH_{(g)}}$$

Thus, moles of $(C_2H_2) = (CH_3-C\equiv CH) < CH_4$

Hence, numerical value of the work done by the system is in the order :

$CaC_2 = Mg_2C_3 < Al_4C_3$

5. (c):

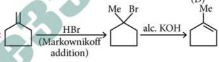


6. (a): $4Na + \underset{(A)}{SiO_2} \longrightarrow \underset{(B)}{2Na_2O} + Si$

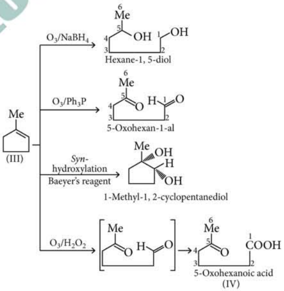
$\underset{(B)}{Na_2O} + H_2O \longrightarrow \underset{(C)}{2NaOH}$

$2NaOH + Si + H_2O \xrightarrow{\Delta} Na_2SiO_3 + \underset{(D)}{2H_2}$

7. (d):



8. (c): Since an acid (5-oxohexanoic acid) is obtained, so oxidative ozonolysis (c) will give this product.



9. (4): Number of X atoms = $8 \times \frac{1}{8}$ = 1 per unit cell

Number of Y atoms = 1 per unit cell

Number of O atoms = $12 \times \frac{1}{4} = 3$ per unit cell

$\therefore$ Formula is $XYO_3 \Rightarrow X_aY_bO_c$

For another structure : Number of O atoms missing from two edge centre per unit cell

$= 10 \times \frac{1}{4} = 2.5$ per unit cell

$\therefore$ Formula is $XYO_{2.5} \equiv X_2Y_2O_5 \Rightarrow X_xY_yO_z$

The value of

$(x + y + z) - (a + b + c) = (2 + 2 + 5) - (1+1+3) = 4$

10. (7) : $[Cr\,Cl_2(en)_2]Cl$, Cr^{3+} ion has $3d^3$ configuration.

Number of unpaired electrons $(X) = 3$

One mole of the complex on reaction with excess $AgNO_3$, will give precipitate of one mole of AgCl.

$\therefore$ Y is 1.

The complex exhibits geometrical isomerism. *cis*-form of the complex will show optical isomerism.

Hence total stereoisomeric forms of the complex $(Z) = 3$

$\therefore$ $X + Y + Z = 3 + 1 + 3 = 7$

◆◆

3 AMAZING FACTS YOU MUST KNOW

1

Gold does not rust

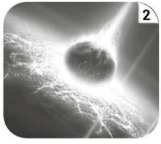
Gold is a noble metal which is chemically inert and does not rust in natural or industrial environments. This is because gold does not react with oxygen. Gold may tarnish due to : (i) Perspiration (ii) Exposure to perfumes and deodorants (iii) Leakage of acid-base cleaning solution.

But higher the karat of the gold in jewellery lower the possibility of tarnishing. Pure gold of 24 Karat does not tarnish no matter how much time passes.

In 2.3 billion years it will be too hot for life to exist on Earth

Over the coming hundreds of millions of years, the Sun will continue to get progressively brighter and hotter. In just over 2 billion years, temperatures will be high enough to evaporate our oceans, making life on Earth impossible. Our planet will become a vast desert similar to Mars today. As it expands into a red giant in the following few billion years, scientists predict that the Sun will finally engulf Earth altogether, spelling the definite end for our planet.

2



3 **STOMACH ACID IS STRONG ENOUGH TO DISSOLVE STAINLESS STEEL**

Stomach acid is strong enough to dissolve stainless steel

The pH of a healthy stomach is usually 1.0-2.0. This low pH level of stomach fluids typically keeps it free of microbes. But at the same time, these pH levels put stomach acid in almost the same category as battery acid, which can dissolve steel. This acid also attacks your stomach lining, which protects itself by secreting an alkali bicarbonate solution. The lining still needs to be replaced continually, and it entirely renews itself every four days.

YOU ASK WE ANSWER

Do you have a question that you just can't get answered?

Use the vast expertise of our MTG team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough. The best questions and their solutions will be printed in this column each month.

1. How does fire work in space?
(Gagandeep Kaur, Punjab)

Ans. Fires in space are not same as fires on earth. You could not just pull out a lighter and start something on fire in space like you could on earth because combustion requires oxygen. When flames burn on earth, heated gases rise from the fire, drawing oxygen in and pushing combustion products out. In microgravity, hot gases don't rise. So an entirely different process, called molecular diffusion, drives flame behaviour. In space, molecular diffusion draws oxygen to the flame and combustion products away from the flame at a 100 times slower than the buoyant flow on earth.

Space flames can also burn at a lower temperature and with less oxygen than fires on earth. As a result, the materials used to put out space fires must be more concentrated.

2. Why is butter solid at room temperature but mustard oil is not? *(Vamsi Krishna, Andhra Pradesh)*

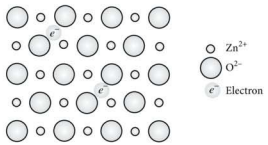
Ans. Butter is a source of animal fat, which is known for higher amount of saturated fat. Saturated fatty acids are molecules that can stretch out straight and stick to other fatty acids around it. As these fatty acids stick to each other, they form a crystalline solid, this compact structure raises the melting point and room temperature is not warm enough to melt it. Whereas mustard oil is a vegetable oil and contains more unsaturated fat. In unsaturated fats, the fatty acid chains contain kinks and bends, so they cannot lie next to each other as tightly and rigidly as with saturated fats, this lowers the melting point and this is why oils are liquid at room temperature.

3. How is chemistry used in hidden crime scene investigation? *(Pritha Dasgupta, West Bengal)*

Ans. Crime scene investigators use technology and chemistry to gather and analyze evidence about crimes. Detectives use a variety of chemicals to uncover evidence at different crime scenes. Forensic scientists use chemicals such as iodine, cyanoacrylate, silver nitrate and ninhydrin to reveal and collect fingerprints. These chemicals react with the substances present in the fingerprints such as oil and sweat, making the prints change colour so analysts can see it better. Another chemical *i.e.*, luminol which is used for blood evidence reacts with iron in the blood. Luminol can reveal blood evidence even if someone has tried to clean up the blood. The forensic scientists spray this chemical on the suspect area and observe the area to see if fluorescence occurs. Forensic scientists also use some common chemicals like hydrogen peroxide and alcohol in combination with other chemicals to produce better results or speed up reaction time. So, if it was not chemistry, crime solving would be much harder.

4. Why does ZnO become yellow when it is heated?
(Uttaran Das)

Ans. ZnO shows metal excess defect by the presence of extra cations in the interstitial sites.



When ZnO is heated, it loses oxygen and turns yellow.

$$ZnO \longrightarrow Zn^{2+} + \frac{1}{2}O_2 + 2e^-$$

The excess of Zn^{2+} ions get trapped into the vacant interstitial sites and the free electrons in the neighbouring interstitial sites. The yellow colour of ZnO, when hot is due to these trapped electrons.

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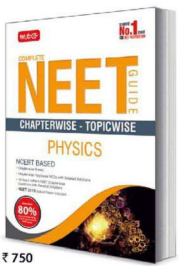

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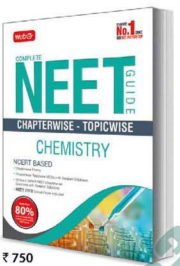

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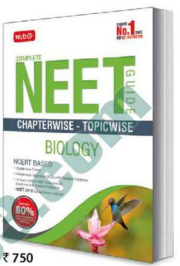

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